III. LOWER AMERICAN RIVER ECOSYSTEMS RESTORATION ALTERNATIVES: ANALYSIS AND RECOMMENDATIONS

AMERICAN RIVER WATERSHED INVESTIGATION

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MEAS.	COVER-TYPE AND ALTERNATIVE	ACRES	CA VOLE		OWL FV		OWL CRV		SFCM		OWM	
			AAHUs	AAAHUs[1]	AAHUs	AAAHUs[2]	AAHUs	AAAHUs[3]	AAHUs	AAAHUs[4]	AAHUs	AAAHUs[5]
6,7	RFO1-B	7.77	1.09	0.22	1.01	0.30	0	0	0	0	0	0
	RFO1-1	7.77	5.36	1.07	6.23	1.87	5.28	2.11	4.74	4.74	0	0
	RFO1-2	7.77	1.09	0.22	1.01	0.30	0	0	0	0	0	0
	RFO2-B	67.31	17.50	3.50	17.50	5.25	0	0	0	0	0	0
	RFO2-1	67.31	46.55	9.31	54.01	16.20	47.50	19.00	0	0	0	0

INTRODUCTION AND BACKGROUND

The lower American River (LAR) refers to the 23 miles of river from Nimbus Dam downstream to the confluence with the Sacramento River. The LAR's flood protection levees begin at the Sacramento River confluence and extend upstream about 14 and 11 miles, respectively, along the north and south banks. In addition, upstream of the flood control levees, natural earthen levees occur along the floodplain associated with portions of the LAR's banks.

Habitat conditions today along the LAR are strongly influenced by the milllions of cubic yards of hydraulic gold-mining sediment and debris which washed down the river, from mining mainly during the mid-1800s. Debris accumulations caused the river bed to rise, effectively raising the low-flow channel by as much a 40 feet. Subsequently, major dams, including Folsom, Nimbus and several other upstream dams built during the mid-1900s, further altered natural river hydrology and severely restricted sediment input into the LAR. The sediment-starving effects of the dams coupled with extensive floodplain sand and gravel mining during the early 1900s gradually depleted natural sediments and caused the LAR channel to lower and become incised.

As a result, the floodplain is now considerably higher above the channel (i.e., high-terrace floodplain) bottom than under natural, unimpaired conditions. The water table is also deeper. Thus, while native riparian vegetation colonized the floodplain during the period of channel raising and today's mature plants with deep root systems are generally vigorous and healthy, only limited natural regeneration of riparian growth now occurs due to the higher, less frequently inundated floodplain. This means that historical riparian habitats have been replaced by high-terrace habitats which are gradually being converted to upland habitats.

Reductions of sediment supply to the LAR have also degraded soil substrate conditions for plant establishment and growth. Any new sediment for habitat regeneration along the channel must be derived in-channel, because upstream reservoirs effectively trap most upstream-derived sediment and there are no significant tributary streams entering the LAR downstream of Nimbus Dam.

The sum of effects is that apparently healthy remaining riparian vegetation along the LAR is not being adequately replaced and can thus be expected to decline both in quality and areal extent over coming decades. Exacerbating the problem are the large number and areal extent of non-native invasive plants which have been colonizing the LAR in recent years. In many cases, non-natives are out-competing and displacing native plants in the limited areas where some natural regeneration might otherwise occur. As a result, a reduction in fish and wildlife habitat quality and carrying capacity can be expected along the LAR in the future, unless an effective intervention program is designed and implemented to restore habitats and ecosystem processes.

The Corps and SAFCA are, in conjunction with this project, considering broad ecosystem restoration alternatives at four sites along the LAR–three high-terrace sites (Woodlake, Urrutia, and Bushy Lake) and one low-terrace/disturbed site (Arden Bar). In addition, a water-temperature-specific restoration measure involving modernization of temperature control shutters at Folsom Dam, is also being considered. In this report, the Service analyzes and then presents its conclusions and recommendations relative to these five potential LAR restoration measures.

I. WOODLAKE SITE

Location and General Description

The Woodlake Site is a broad, high-terrace floodplain along the north side of the American River which was formed during the mid-1800s from hydraulic mining debris and sediment washed down the river (see JSA Plates 1,4). The site is roughly opposite present River Mile (RM) 3, and is thus about 3 miles upstream of the confluence of the American and Sacramento rivers. The City of Sacramento landfill lies to the south of the site just outside of the river's left-bank (downstream aspect) levee. The site is bounded: on the south by about 7,228 linear feet of river; on the north by about 6,528 linear feet of levee; on the west by the Union Pacific Railroad bridge and track; and on the east by the Southern Pacific Railroad bridge and track. The site averages about 6,878 feet in length and 1,748 feet in width, thus comprising about 274 acres.

Cover-Type Delineations and Mapping

Mapping of the cover-types of the Woodlake site was completed by the U.S. Army Corps of Engineers (Corps') consultant, Jones and Stokes Associates (JSA) of Sacramento, California. A combination of aerial photographic interpretation and ground-truthing was employed. Using information in a GIS data base, JSA created a separate map for existing (baseline) conditions and for each of two preliminary action alternatives[1]. These maps included topographic contour lines and were based on aerial photography of the river corridor acquired by the Corps in 1997.

Cover-Type Acreages

JSA provided acreages directly on the maps for most of the mapped polygons. These were generated using appropriate GIS software. For the few instances in which acreages of polygons or other areas of interest were not specifically provided on the maps by JSA, they were measured by a U.S. Fish and Wildlife Service (Service) technician or biologist using an electronic planimeter. A summary of the acreages for baseline conditions and as currently projected for each of the two preliminary "concept design" action alternatives is provided in Table 1.

Table 1. Cover-type acreages, Woodlake restoration site, for Baseline, Alternative 1, and

[1]These alternatives are not necessarily synonymous with the Corps' alternatives for the project. The Corps considered JSA's alternatives as an assemblage of "measures" from which alternatives could be derived using established Corps planning processes and principles. Measures are described later herein.

Alternative 2. Bolded figures are acreages to be *created*, with actual net increases of new area in parentheses. Letter-number codes refer to specific mapped polygons.

COVER-TYPE(S)	ACREAGES		
	BASELINE	ALTERNATIVE 1	ALTERNATIVE 2
Seasonal Wetland	8.36 2.60	**SW1-3.34**(3.34) **SW2-2.61**(0.00)	**SW1-14.35**(5.99)
Seasonal Wetland "Pits" (w* or w/out** "stranding")	4.80* 2.14*	**SW3-5.57****(0.77) **SW4-3.07****(0.93)	**SW2-5.57****(0.77) **SW3-3.07****(0.93)
Subtotal Wetland Types	17.90	**14.59**(5.04)	**22.99**(7.69)
Riparian Scrub	4.18	0	0
Riparian Forest	2.37	**RP1-27.75**(25.24) **RP2-15.73**(13.12) **RP3-4.76**(2.31) 2.37	**RP1-8.47**(8.47) **RP2-14.51**(12.49) **RP3-4.79**(2.35) 2.37
Riparian Forest/Perm. Wetland	20.91	20.91	20.91
Mixed Riparian Forest	44.43	40.14	41.86
Riparian Oak Woodland	12.20	**OW1-5.99**(5.99) **OW2-11.37**(11.37) 12.22	**OW1-4.98**(4.98) **OW2-11.16**(11.16) 12.22
Oak Woodland/Savannah	4.42	**OS1-13.20**(13.20) **OS2-16.89**(16.62) **OS3-18.64**(17.67) 3.85	**OS1-8.42**(8.42) **OS2-9.10**(8.83) **OS3-11.56**(10.59) 3.85
Mature Trees	0.99	0	0
Cottonwoods	1.71	0	0.83
Black Locust Grove	0.38	0.38	0.38
Subtotal Forest Types	91.59	194.20(105.52)	155.41(67.29)
Ruderal (Grasses/Thistle)	163.54	0.44	1.45
Grassland	0	**GR1-62.64**(61.92)	**GR1-93.18**(92.46)
Shallow Aquatic	0	**SQ1-1.16**(1.16)	0
Existing Elderberry Mitigation	0.77	0.77	0.77
TOTAL	273.80	273.80	273.80

An issue that had to be addressed in reconciling acreage figures among JSA's maps for display in

Table 1 concerned the fact that occasionally, a given mapped polygon for one of the preliminary action alternatives overlapped all or part of a (baseline) mapped area with existing moderate-to-high habitat value. In a few instances, such an existing area would likely have to be destroyed or substantially modified in creating one of the new habitat areas (addressed in assumptions; *see* Appendix B8), and the HEP accounting process tracked the projected changes accordingly. In other instances, the overlapped higher-valued habitat area would be expected to remain intact or largely undisturbed in creating the new cover-type area. For example, the proposed riparian forest area (RIP 1) of Alternative 1 would overlap a 0.83-acre stand of large cottonwoods, which, except for the small stand size have moderate-to-high existing value. It was assumed that this stand would not be destroyed, but merely incorporated as is into the new, larger riparian forest area being created.

The values in Table 1 reflect any necessary adjustments made to reconcile all issues involving overlapping polygons. Thus, for example, under Alternative 1, 105.51 acres of *new* area of forest types would be created instead of the 114.33 acres indicated by JSA on the cover-type map for this alternative. Similarly, under Alternative 2, the actual total size of *new* forested area created would be 67.29 acres instead of the 72.99 acres shown on the cover-type map for this alternative. (Similar acreage reconciliations were also completed for the subsequent HEP calculations at the three other proposed sites to ensure that existing, high-value areas being incorporated into new cover-types were fairly and accurately accounted for.)

Existing Cover-Types and Conditions

Ruderal. Much of the Woodlake site's existing acreage–163.5 acres–was classified by JSA as "annual grasses and (yellow) starthistle." Throughout the HEP, this acreage had been called "ruderal"(Table 1). The ruderal area covers most of the central portion of the site and is composed mainly of various grasses and forbs. Yellow starthistle, an introduced weed, is the most abundant ruderal plant. Several significant stands of other introduced weeds, including cockleburr, are also scattered throughout the ruderal area.

Forested. A total of 91.6 acres of the site are currently in forested types, including riparian scrub (4.18 acres); mixed riparian forest (44.4 acres); riparian forest and permanent wetland (20.9 acres); oak riparian woodland (12.2 acres); oak woodland/savannah (4.4 acres); riparian forest (2.4 acres); and three other small occurrences of trees (3.1 acres total; Table 1). Tree species making up the forested areas include typical riparian/woodland species such as cottonwood, oaks, black walnut, black locust, Oregon ash, box elder, sycamore, willows, and others.

The highest-valued (to fish and wildlife) forested areas currently occur in strips along the south and north borders of the site, along the river, and just inside the northern perimeter river levee. The northern 17-acre forested strip is particularly high in habitat value due to the presence of multiple canopy layers, several woody species, and semi-permanent water in a low drainage area extending along the levee. This drainage area was created when borrow was removed (date unknown), apparently to construct or improve the levee along this reach. The diversity of occurrences (patchiness) and diverse structure of the various forest types are an integral component to the relatively high habitat values of the Woodlake site as a whole.

Seasonal Wetlands. A total of 17.9 acres of the site were mapped (JSA Plate 4) as seasonal wetlands (Table 1). The largest single contiguous seasonal wetland occurrence of 8.4 acres is in the west-central portion of the site; a similar, but smaller occurrence of 2.6 acres exists in the northwestern corner of the site. These two occurrences are simply broad, shallow depressions atop the high-terrace floodplain. Neither of these wetlands occurrences has any wetlands plants; plant domination instead is by the same ruderal plant species that occur in the ruderal area.

Two other seasonal wetlands occurrences on the site of 4.8 and 2.1 acres, respectively, are within a 19.1-acre block of mixed riparian forest along the southwestern edge of the site(JSA Plate 4). These two wetlands occurrences are also lacking in wetlands vegetation, with domination instead by woody riparian plants. Both of these wetlands occurrences are essentially overflow “pits” created during previous (date unknown) borrow extraction operations, possibly for construction or repair of nearby levees. The two pits are periodically flooded when the river overflows across several low points in the high-terrace berm which separates them from the river. Fish which enter the pits during overflow conditions are subject to “stranding,” especially if the river later quickly recedes. Stranded fish then become subject to mortality due to poor water quality, predation by birds, and eventual dewatering, if the river fails to subsequently re-flood the pit again during the same rainy season.

The other two seasonal wetlands of the site (8.4 and 2.6-acres, respectively) also presumably experience the same stranding and mortality problems, but probably to a much lesser degree, since they are both much shallower and less frequently flooded. Unfortunately, no quantitative assessments have been done on any of the four existing seasonal wetlands occurrences to measure the degree of stranding or associated mortality. Among concerns would be any stranding mortality occurring to Sacramento splittail and Central Valley steelhead, two federally listed species which breed in the American River. In addition, any stranding losses of winter-run chinook salmon or Central Valley spring-run chinook salmon, two other federally listed species occurring elsewhere, but regularly straying into the American river, would be of concern.

The Woodlake site’s various seasonal wetlands are periodically flooded during the rainy season from either (or combinations of): (a) the river rising and overtopping all or part of the high terrace of the site; (b) very high, or prolonged, single rainfall events, which may create localized “ponding”; or (c) overflows from the semi-permanent channel along the north levee, which is in turn flooded by urban storm drainage runoff pumped into the channel from outside the levee. Our recent observations suggest that the latter source of flooding may be most common.

Despite occasional fish stranding and subsequent mortality associated with the site’s two overflow pits and, at times, the two ruderal-area seasonal wetland depressions, the overall value of the Woodlake site's seasonal wetlands is at least moderately high. Diversity of wetlands type, shape, and size, and patchiness of their distribution, are factors contributing to the high values.

Mitigation Plantings. The northeast corner of the site has several young elderberry bush plantings on an 0.8-acre area (Table 1; JSA Plate 4). These were recently planted as mitigation for impacts to the federally threatened valley elderberry longhorn beetle at projects from outside of the river corridor

Utility Structures. The site is traversed roughly from east to west by several large-capacity power lines suspended from high metal towers. In addition, three large radio transmission antennas with their supporting cables and associated equipment trailer are located in the ruderal area within the south-central portion of the site.

Under dense fog conditions which periodically occur during the rainy season, this utility/radio infrastructure may at times be a significant source of avian mortality. Birds most likely to be impacted are hawks, owls, waterfowl, and the larger waterbirds, such as herons and egrets. We recently found two egret carcasses and a pheasant carcass on the site which may have been victims of collisions with the power and radio infrastructure of the site.

Roads. An unimproved (occasionally graded) dirt road network traverses both the perimeter and central portion of the site in the vicinity of the radio antennas. In addition, several vehicle trails traverse or encompass several of the forest areas. An important function of all such roads is their utility as firebreaks.

Previous Agricultural Use

Domination of the site by yellow starthistle is apparently a recent phenomenon. For at least 20 years prior to 1999, Sacramento County Department of Parks and Recreation leased most of what is now the ruderal area for farming. The primary agricultural commodity was hay, although safflower and a few other grain crops were sporadically grown. Although the farming lease was a small source of income to the County (<$1,000/year), it was deemed desirable because the lessee's farming operations were an effective way of controlling the starthistle problem. In addition, the lessee was required to maintain several of the roads as firebreaks, thereby reducing the County's maintenance requirement. However, in 1999, due to repeated lease violations, the County canceled the agreement with the lessee. The area has thus been fallow and untilled for about 2 years, which has greatly exacerbated the starthistle problem as well as the fire danger.

A County official recently queried by the Service stated that the County has no immediate plan or desire to reinstate the farming lease, and that the firebreak maintenance work previously done by the lessee has recently been resumed by the County. The County is not currently attempting to manage or otherwise control the yellow starthistle invasion, however.

Existing Wildlife Species

Due to its relatively large size, diversity of cover-types, and relatively high existing habitat values, the Woodlake site has both high abundance and diversity of wildlife. Small mammals either recently observed by Service biologists or expected to occur on the area include opossum, hare, gray squirrel, ground squirrel, vole, muskrat, deer mouse, ringtail, weasel, mink, and skunks. Mid-to-large size resident or transitory mammals likely include beaver, coyote, fox, raccoon, river otter, and mule deer. Amphibians likely include both toads and frogs. Reptiles likely include the pond turtle, various lizards and skinks, and several snakes.

A highly diverse array of birds utilizes the site. Many species are permanent residents while others are seasonal visitors. Included are numerous passerine species, waterfowl, herons, egrets, various other water birds, and both a large number and diversity of raptor (hawk and owl) species.

Raptor values on the site are exceptionally high due to (1) the diversity and mosaic-patterning of cover-types; (2) the diversity and abundance of roosting, nesting, and feeding perches and substrates in the form of large and small trees; and (3) the large ruderal area (area formerly farmed) available for foraging on preferred small mammal prey.

Service biologists have recently observed multiple individuals of most of the following raptor species on the site: great-horned owl, barn owl, white-tailed kite, Cooper's hawk, sharp-shined hawk, northern harrier, rough-legged hawk, red-tailed hawk, red-shouldered hawk, merlin, and American kestrel. During each of several recent (November 2000-January 2001) brief (1-hour) surveys around the perimeter of the site by automobile, 20-30 individual raptors comprising 6-8 species were recorded. These recent observations have tallied only the wintering use of the site by raptors. In addition, a relatively large number of possible raptor nest sites were observed throughout the forested area of the site. Our conclusion is that the Woodlake site may be one of the most, if not the most, valuable raptor habitat areas within the Sacramento city limits. This conclusion has played a key role in our design and application of the HEP for this site.

Alternatives Evaluated

Each of the two preliminary concept design restoration alternatives (*see* earlier footnote 1), as designed and mapped by JSA, were evaluated. The two alternatives would target a similar amount of the site's existing acreage–192.7 acres (Alternative 1) versus 189.2 acres (Alternative 2). However, in Alternative 1 the focus would be on creation of forest types (114.3 acres) followed by grassland creation (62.6 acres), whereas Alternative 2 would focus more on grassland (93.2 acres) and less on various forest types (73.0 acres; Table 1). Alternative 1 would also focus much more than Alternative 2 on the goal of restoration of ecosystem *processes* and *function*, via a combined riparian forest (27.8 acres)-seasonal wetland (3.3 acres)-shallow aquatic (1.1 acres) area that would be created in the southwest corner of the site (polygons RIP1, SW1, and SAQ1, respectively on JSA's baseline map [Plate 1]). This multi-cover area would become hydrologically connected to, and influenced by, the American River.

In each alternative, most of the "new" habitat area would be derived from existing ruderal area, although a number of small conversions of other habitats would also be necessary. Also, under each alternative, the two existing hydrologic connections between the two existing stranding pits and the river would be improved. In addition, under Alternative 1, a third (new) hydrologic connection would be created from the river to the new RIP1-SW1-SQA1 habitat area (and western portion of the larger stranding pit.)

Under each alternative, there would be some relatively small losses of existing moderate-to-high-value forested habitat. For example, under each alternative, 0.30-acre of mixed riparian forest would be removed for constructing the two improved connections between the stranding pits and the river. Also, under each alternative, 0.88 acre of mixed riparian forest would be removed during grading and contouring prior to planting a new block (RIP3) of riparian forest along the eastern edge of the site. In addition, under Alternative 1, the other large additional connection to the river (i.e., for combined RIP1-SW1-SQA1 cover-types) would necessitate removal of an additional 1.72 acres of mixed riparian forest. And finally, depending on alternative, either 0.53 acre of riparian shrub/oak/cottonwood or seasonal wetland shrub (RIP2[Alt.1] or RIP2[Alt.2], respectively) would be lost during excavation and grading to create other new blocks of riparian forest. These would constitute the only significant losses of existing habitat; nearly all of the remaining habitat conversions would occur on existing ruderal area which is dominated by yellow starthistle. However, this does assume, as discussed earlier, that several small, relatively high-value patches of existing forest area would be incorporated as is (i.e., no loss of their existing values) into new cover-types.

Although the two preliminary concept alternatives were evaluated overall as if they were the only potential alternatives, we also conducted the HEP accounting and analysis in a very detailed manner down to the level of individual cover-types and individual polygons within cover-types. This high level of detail was necessary to enable the Corps to develop (and compare) such additional alternatives as could be derived using its established planning principles, processes, and procedures. The additional alternatives development by the Corps (and the Corps' incremental cost analysis) was done using specific "measures" which could be separated out of each of the two action alternatives. (Note: The Corps' evaluations, based on incremental cost analyses, have recently resulted in development of a theoretical "best buy" alternative for each restoration site. Each best buy alternative is briefly discussed below following the Results and Discussion section for the two concept design alternatives of each site.)

Measures

The Corps and JSA have developed a total of 25 potential restoration measures for use in the proposed actions involving the four possible restoration sites. Nine of these restoration measures apply to the Woodlake sites concept designs and best buy alternative, as follows:

- *Measure 4*–Plant wetland species (SW2 [Alt.1]; SW1 [Alt.2]);

- *Measure 5*–Grade the floodplain terrace to create appropriate hydrology for seasonal wetland habitat, and plant season wetland species (Not applicable to the Woodlake site);

- *Measure 6*–Plant riparian forest species (RIP1 [Alt.2]).

- *Measure 7*–Grade the floodplain terrace to create appropriate hydrology for riparian forest habitat, and plant riparian forest species (RIP2-3[Alt.1-2]);

- *Measure 8*–Plant riparian oak woodland species (ROW1-2[Alt.1-2]);

- *Measure 9*–Plant oak savannah species (OWS1-3[Alt.1-2]);

- *Measure 10*–Plant permanent grassland (GR1[Alt.1-2]);

- *Measure 13*–Excavate and grade to create side-channels off the river with appropriate hydrologic connection to the river, and plant shallow aquatic, seasonal wetland, and riparian forest species (SAQ1, SW1, and RIP1 [Alt.1]);

- *Measure 16*–Restore free-flow hydrologic connectivity between the river and adjacent floodplain terrace, including sinks or "pits," by lowering berms (SW3-4 [Alt.1]; SW2-3 [Alt.2]);

Goals Governing the HEP Application

A broad goal shared by the Corps, SAFCA, and Service for the evaluations of the four possible sites is the restoration of significant ecosystem function, structure, and dynamic processes that have been degraded along the LAR. Achieving this broad goal might entail restoring diverse native plant communities and habitats, improving connectivity and functionality between habitats, re-creating hydrologic interaction between the river and its floodplain areas, and reducing potential for fish stranding in unnatural or adversely modified floodplain areas. These potential actions are reflected in the measures described above.

In addition to these overriding goals, the Service has several site-specific goals keyed to existing fish and wildlife conditions of the Woodlake site which governed how the HEP was designed and executed. These site-specific goals are: (1) to *preserve or improve overall* fish and wildlife habitat values to the extent feasible; (2) to *minimize losses* of any *high-value habitat* in the process of creating other new habitats; (3) ensure *no loss of any habitat values for raptors*; and

(4) *improve habitat values for adult and juvenile Sacramento splittail, and juvenile salmonids.*

HEP Team

A relatively short time limit desired by the Corps for completion of the HEP precluded the Service from utilizing a traditional multi-agency team approach to set objectives, identify HSI (Habitat Suitability Index) models, develop futures assumptions, and derive other key HEP elements. However, en lieu of multiple HEP team meetings, the Service has provided at various milestones, written drafts of the HEP for appropriate outside agency review and comment. Review comments have been and are being incorporated as appropriate and when received.

Agencies and individuals on the review list were: Service–Jason Douglas and Stephanie Brady; National Marine Fisheries Service–Shirley Witalis; California Department of Fish and Game–Terry Roscoe; Corps–David Tedrick, Susan Rosebrough, and Sharon McHale; California Department of Water Resources–Earle Cummings and Debra Condon; JSA–Brian Higgins; SAFCA–Peter Buck and Karen Hondrick; and Sacramento County Department of Regional Parks, Recreation and Open Space–Mary Maret.

HEP Overview

An important underlying requisite of the HEP results was that they must facilitate objective comparisons of: (a) the two Woodlake site concept alternatives (and such additional alternatives as the Corps developed from analysis of the individual *elements* of these alternatives); and (b) these alternatives versus other action alternatives developed by JSA and the Corps for the three other potential LAR restoration sites. Based on the objective comparisons requisite, and the short time limit, a relatively simple HEP–in terms of both species models and variables–was designed and implemented as summarized in Table 2.

First, based on JSA's habitat mapping, 13 cover-types were identified for tracking in the HEP (Table 2). Included were the cover-types that would be created, adversely affected, or would be unaffected (but nevertheless considered important in *overall* evaluation of the site's ecosystem values and functioning aspects). The suite of cover-types included two uplands types–ruderal and grassland; six forest types–oak woodland/savannah, riparian oak woodland, mixed riparian forest, riparian forest/wetland, riparian forest, and small groups of trees (mature trees, cottonwoods, and black locust grove); and four wetlands types–seasonal wetland, seasonal wetland "pits," seasonal wetland/shrub, and shallow aquatic.

Table 2. Cover-types, HSI models and measurement variables for the Woodlake restoration site HEP application.

COVER-TYPES (CT)	HSI MODELS	HSI VARIABLES (Suitability Indexes=SIs)

1. Ruderal 2. Grassland	California Vole	V_1-Herbaceous Vegetation Height
		V_2-Herbaceous Vegetation Cover Percent
		V_3-Soil Type
	Great-horned Owl FV (FV=Food Value)	V_1-Herbaceous Vegetation Cover Percent
		V_2-Herbaceous 6-36-inch Cover Percent
3. Oak Woodland/ Savannah 5. Riparian Oak-Woodland 6. Mixed Riparian Forest 7. Riparian Forest/ Wetland 8. Riparian Forest 9. Small Groups of Trees (Various)	California Vole	V_1-V_3–Same as California Vole for CTs1-2, +
		V_4-Presence of Logs/Other Types of Cover
	Great-horned Owl FV	V_1-V_2–Same as Owl FV for CTs1-2 , +
		V_4-Shrub Cover Percent
	Great-horned Owl CRV (CRV=Cover and Re-production Value)	V_6-Forest Overstory Size
		V_7-Size of Forested Areas
10. Seasonal Wetland 11. Seasonal Wetland "Pits" 12. Seasonal Wetland/ Shrub 13. Shallow Aquatic	California Vole	V_1-V_3–Same as California Vole for CTs1-2 (except V_4 included for "stranding pits")
	Great-horned Owl FV	V_1-V_2-Same as Owl FV for CTs1-2 (except V_4 included for "stranding pits")
	Great-horned Owl CRV	V_6-V_7-(For stranding pits only) same as CTs3-5
	Seasonal Floodplain Habitat Community Model=SFCM (Where Applicable)	V_1-Number Woody Tree/Shrub Species
		V_2-Fraction of Area Covered by Tree Canopy
		V_3-Number of Levels with Vegetative Cover
		V_4-Predominant Bottom Substrate Type
		V_5-Percent Detritus/Organic Debris Cover
		V_6-Annual Cumulative Duration of Flooding
		V_7-Type of Hydrologic Connection to River

The first evaluation species selected was the California vole. This particular HSI model was used mainly to ensure tracking of changes to the small mammal prey base of importance to various raptors which utilize the site. The model uses either three or four simple variables, depending on cover-type (Table 2). The resulting HSI is meant to reflect small mammal–such as voles and mice–densities. However, the model should also broadly reflect densities of certain larger raptor prey on the site, including black-tailed jackrabbits and ground squirrels. In addition, the model's variables, particularly those for herbaceous vegetation height and percent cover–are general indicators of habitat conditions for a suite of other wildlife species including (and depending on cover-type) other small-or mid-sized mammals and various birds which occur along the river corridor. The vole model was applied across all of the cover-types for the Woodlake site.

Although the vole model addressed the *presence* of small mammals for raptor prey (as well as presence of other wildlife), it may not always indicate relative *availability* of such prey to various raptor species. To ensure prey availability was also tracked, the food value (FV) element of the great-horned owl HSI model (i.e., FV element=HSI; Table 2) was used. The key premises behind the FV element variables (either three or four, depending on cover-type) are that optimum owl foraging *ability and success* occurs where vegetative growth on the ground (either herbaceous or woody) is at least moderately dense and is between roughly 6 and 36 inches in height. Moreover, we assumed that as great-horned owl foraging conditions improve, so do foraging conditions for several other raptor species. The owl HSI for FV was tracked across all of the cover-types.

Assuring that raptor values on the site are maintained also requires consideration of large, mature trees. Such trees are important to a wide range of raptors for use as roosting, perching (for hunting or resting) and nesting substrates. This element was tracked in the analysis using the cover and reproduction value (CRV=HSI; Table 2) of the great-horned owl HSI model. Owl CRV was tracked across all cover-type occurrences with existing or projected (under an action alternative) tree cover. Two simple variables (Table 2) were always employed regardless of cover-type. The underlying premises were that the larger the “patch” of forest (or treed area) and the larger the trees in that patch, the greater the owl CRV. As with owl FV, we also assumed that as the owl’s CRV improves, so does cover and reproduction value for several other raptor species.

Use of the owl FV and CRV variables was also an effective way of tracking the basic attributes of forest areas, including riparian forest, which provide general fish and wildlife habitat values. In particular, many HSI models for various forest and riparian species contain SIs relating to tree size (larger is better), patch size (larger is better; narrow, linear strips are often limited in value), and understory density (denser is better). Thus, by tracking these attributes via the owl FV and CRV variables and HSIs, general habitat values to a wide range of other forest-dwelling birds, mammals, reptiles, and amphibians of the LAR have been effectively measured.

The final attributes that needed to be measured and tracked in the HEP related to the seasonal floodplain habitat values, with particular emphasis on Sacramento splittail and juvenile anadromous salmonids. The Service’s existing community-based HSI model for Shaded Riverine Aquatic (SRA) cover was considered for this accounting, but deemed inappropriate. The SRA cover model focuses on habitat variables important along a permanently flooded stream bank. Such variables may thus not adequately portray habitat values over much broader or more diverse floodplain areas where both inundation periodicity and duration vary widely. Instead of attempting to modify the existing SRA Cover model for use in this HEP, a new (draft) community-based model for seasonally inundated floodplain habitat (Seasonal Floodplain Habitat Community Model=SFCM) of the LAR was developed and used.

The SFCM employs seven variables to derive HSIs (Table 2) in selected floodplain habitats. The theory behind the model is that habitat value for both splittail and juvenile salmonids is directly related to the amount of food and cover provided, duration of inundation, and type and degree of hydrologic connection of the floodplain to the river. Hydrologic connection is represented by one variable and is assumed to comprise 38% (5/13) of HSI value. Food and cover, which is an aggregate of five variables, also comprises 38% (5/13) of HSI value. Inundation duration is also represented by a single variable, which because of its intermediate importance comprises 23% (3/13) of HSI value. The SFCM was applied, where applicable (i.e., for any existing or planned floodplain area having a hydrologic connection to the river), for tracking habitat values in various occurrences of the four wetland cover-types (Table 2).

A final consideration in the Woodlake site HEP design and implementation was its scope–in terms of the acreage(s) to be accounted for. Often such analyses focus only on the actual area(s) of habitat proposed to be impacted or changed. However, such an approach may not have been appropriate for the Woodlake site analysis, because of the ecosystem restoration-related goals. For at least this one site, we considered it appropriate to account for acreages and values of the whole site.

Thus, although roughly a third of the site would not undergo any modifications of cover-types due to either of the two JSA action alternatives, basic HEP assessment and accounting was done over the entire 274-acre area as well as for the impacted areas. This necessitated projections of future conditions for all cover-type occurrences–both impacted and non-impacted. In this manner, preservation of overall existing habitat values and functioning keyed to raptors, and implications to ecosystem functioning, were more effectively addressed.

The HSI models that were used for the California vole and great-horned owl (i.e., HSIs for owl FV and owl CRV) are the same as those used for the other two large HEP applications associated with this project (and attached hereto). These two models can thus be found in the appropriate appendices to these two associated HEPs. The SFCM that was developed and used for the Woodlake site is attached hereto as Appendix A, however.

Sampling and Variable Measurement Methods

All baseline (existing) habitat conditions were evaluated from field sampling of the various cover-types during December and January 2000-2001. Most of the Suitability Indexes (SIs) for various models were derived from visual estimates (usually, the average of two observers) involving the variable criteria. Visual estimates were usually made within 1 m^2 plots systematically located along systematically placed transects. Sample size was generally proportional to acreage of the habitat occurrence, although the expected degree of variability was also sometimes used as a sample size determinant. Detailed descriptions of specific sampling procedures for the key mapped polygons (*see* JSA's Plates for this site) follow below. The actual sampling results and various SIs and HSIs derived from them are attached in Appendix B.

Seasonal Wetland Pit-SW3 (Alt. 1)/SW2 (Alt. 2). This is the larger of the two existing stranding pits. Two equally-spaced transects were established in an east-west direction through the long axis of the 4.8-acre area, and 1 m^2 plots were located every 100 feet along each transect. The various California vole, great-horned owl FV, great-horned owl CRV, and Seasonal Floodplain Community Model (SFCM) variables (Table 2) were visually estimated within the 1m^2 plots. The only exception was that variable V_1 (number of woody tree/shrub species) of the SFCM, was assessed by counting the species present within a 25-ft radius of the center of each 1 m^2 plot. Based on the existing hydrology at the site, V_6 and V_7 for the SFCM were both assumed to have a SI of 0.2 in all sample plots. Each transect had 16 plots, thus a total of 32 plots were evaluated. For each of the four species being tracked, an HSI was first derived for each plot and then a mean HSI was derived for all 32 plots. The mean HSI was used in the HEP accounting.

Seasonal Wetland Pit-SW4 (Alt. 1)/SW3 (Alt. 2). This is the smaller of the two stranding pits. Sampling was done the same as for the other stranding pit, except that three north-south oriented transects were equally spaced across the 2.1-acre area. A total of 19 sample 1 m^2 plots were assessed, and HSIs were calculated the same as for the other stranding pit. However, based on this pit's hydrology, the assumed existing values of V_6 and V_7 for the SFCM were 0.0 and 0.2, respectively, for all sample plots.

Shallow Aquatic (SAQ1-Alt.1) and Seasonal Wetland (SW1-Alt.1). To construct the westerly portions of SAQ1 and SW1 as described in JSA's Alternative 1, about 1.5 acres of mixed riparian forest would have to be removed. The cleared area would then be lowered, graded to provide appropriate contours, and planted with appropriate wetlands plants. This existing forest area was sampled, and the SIs and HSIs were calculated for the relevant evaluation species (vole, owl FV and owl CRV; Table 2) the same as for the two stranding pits, except that sampling was done along six north-south transects and the 1 m^2 plots were at 12 m intervals. A total of 35 plots was sampled from which the average HSI for each evaluation species was calculated.

Seasonal Wetland (8.4 acres-JSA "Baseline" Plate). The existing 8.4-acre seasonal wetland in the west-central portion of the Woodlake site would be converted to either a larger riparian forest block (Alternative 1) or to a slightly larger and improved season wetland (Alternative 2). The existing wetland area was sampled and the SIs and HSIs were derived the same as for the other seasonal wetlands, with two exceptions. First, owl CRV was not accounted for, since no trees exist or would be created under the alternatives. Second, sampling was done along only one transect through the center of the long axis of the wetland, with the 1 m^2 sampling plots spaced at

13 m intervals. A total of 30 plots was thus used to derive a mean HSI for each of the three evaluation species–vole, owl FV, and SFCM.

Seasonal Wetland (2.6 acres-JSA "Baseline" Plate). The existing 2.6-acre seasonal wetland near the western edge of the Woodlake site would be either enlarged and improved (Alternative 1) or converted to grassland (Alternative 2). The existing wetland area was sampled along one east-west transect through the long axis of the site, with plots 11 m apart for a total of 20 plots. Otherwise, all procedures were the same as for the 8.4-acre seasonal wetland.

Ruderal Area. Virtually all of the existing 163.5 acres of ruderal area on the site would be converted to grassland and various forest types (riparian forest, riparian oak woodland, or oak woodland/savannah), with the acreages of the new cover-types depending on alternative. The ruderal area was sampled along one long, roughly east-west transect through the long axis of the site. Sample plots were spaced 125 m apart, resulting in 60 total plots from which the average HSIs for the two evaluation species (vole and owl FV) were derived.

Forested Areas. Other than the 2.0 acres of mixed riparian forest that would have to be removed under Alternative 1, the site's existing forested areas would not be affected by any measures in the two concept design alternatives. Nevertheless, as explained earlier, non-impacted forest areas were tracked in the HEP in addition to impacted areas. The various occurrences of existing forest were sampled (and SIs and HSIs were derived) the same as for the 1.5-acre mixed riparian forest area, except that transect numbers and sample plot spacings varied by mapped occurrence (polygons on JSA's Baseline Plate). Sample sizes used, SIs, plot HSIs, and mean HSIs for evaluation species for the site's 14 existing forested areas are also provided in Appendix B.

Mean Weighted HSIs

In several instances, the "footprint" of an element within a measure (i.e., new cover-type polygon) within an action alternative would overlay more than one existing cover-type. Sometimes when this occurred, the HEP accounting could be conducted by cover-type with the values from the cover-types summed. In other instances, it was easier to calculate *mean weighted* HSIs for evaluation species occurring across more than one cover-type. When this was done, the weighting factor always used was *acreage* of the cover-type occurrence. Although the numerous and sometimes lengthy calculations of mean weighted HSIs are not provided herein, the values themselves appear in the HEP Form Cs for deriving Average Annual Habitat Units (AAHUs).   Because of their large bulk, however, the numerous HEP Form Cs were not appended hereto. They are available upon request from the Corps Projects Branch of the Service's Sacramento Office.

Futures Projections and HSI Derivations

As in any HEP, the *future* SI (by Target Year [TY]) for each model variable of each evaluation species (Table 2) had to be *projected* for use in the HEP accounting. This necessitated dozens of assumptions based on best professional biological judgement and knowledge of the development of various restored and re-created habitats. Again, due to their sheer volume, the hundreds of individual SIs by TYs that were projected in this manner are not appended hereto. However, just as for the HEP Form Cs (which utilize these projected values), they are available upon request from the Corps Projects Branch at the Service's Sacramento Office. In addition, Appendix C hereto provides extensive narrative discussions of the underlying concepts, assumptions, and principles upon which the futures projections were made.

Target Years Used in the Analyses

The HEP accounting period of analysis was 50 years. Although a more lengthy period was desired by some of the cooperating agencies, the Service determined that 50 years was an upper limit for making realistic and reasonably biologically valid projections, given the alternatives (and measures) under consideration.

Fixed TYs were not applied across all of the various cover-types. Instead, based on the assumptions and futures projections relating to each individual cover-type and mapped polygon (Appendix C), an appropriate number and interval of TYs were identified and used in the HEP accounting. The TYs that were applied to each cover-type and polygon are given within the Appendix C discussions and they also appear on the HEP Form Cs.

HEP Output/Results

The first step was to summarize the HEP output in terms of AAHUs by alternative, cover-type and evaluation species (Table 3). Next, *adjusted* AAHUs (AAAHUs) were derived for the baseline (existing) conditions for the entire 274-acre site (Table 4). The AAAHUs were the products of each species/cover-type AAHU and the Relative Value Index (RVI; *see* following section) for that evaluation species. Lastly, AAAHUs were summarized by measure and individual polygon for each of the two preliminary conceptual action alternatives (Table 5). The Table 5 values were the basis for most of the Service's conclusions and recommendations regarding the Woodlake site. However, as discussed earlier, a corollary purpose in deriving and presenting AAAHUs by measure (and cover-type) was to facilitate the Corps' derivation of additional best-buy alternatives and completion of its required incremental cost analysis.

Relative Value Indices

RVIs are used in HEP to facilitate consideration of factors not considered in determining HUs for the evaluation species. These factors can include various environmental, social, and economic criteria believed to be important to a future land or water use decision. Usually, identified criteria are weighted according to their importance when compared to other criteria. Each evaluation species is then ranked according to each criterion. The process results in a RVI, which is simply an index between 0 and 1.0, for quantifying importance of each evaluation species relative to the other evaluation species. This index can then be applied as a weighting factor to the HUs or AAHUs of the evaluation species to yield *relative* habitat units. In the tabular results of the HEP accounting below (and including the other three restoration sites), we have used AAAHUs to mean *Adjusted* AAHUs which represents *relative* AAHUs. The AAAHUs were then used directly in most comparisons to derive various conclusions and recommendations.

The RVIs for evaluation species in the Woodlake site HEP are: SFCM–1.0; owl CRV–0.4; owl FV–0.3; and California vole–0.2. Although these values were derived absent a rigorous process, they nevertheless are based upon several important considerations. First, SFCM value has the highest (1.0) RVI, because it represents potential *recovery* value for several federally listed fish species and provides the surest indicator that the broad goal of restoration of significant ecosystem function, structure, and processes is met. Owl CRV at 0.4 is the next most important, because it represents creation of riparian-association stands of forest. Such stands benefit a wide range of fish and wildlife species and are widely agreed to be a worthy restoration goal in the Central Valley and elsewhere in California, where very large losses of such cover-types have occurred in relation to historic, pristine conditions. Owl FV at 0.3 is next in importance, and slightly lower than owl CRV, because it represents only the understory component to forest habitat values. Finally, the vole at 0.2 is lowest because it represents only the herbaceous ground cover component of native plant restoration.

Results and Discussion

The HEP accounting quantified the considerable gains in habitat value that would accrue under each of the concept design alternatives. Using the *unadjusted* (by RVIs) accounting results, Alternatives 1 and 2 would create 549 and 535 AAHUs, respectively, compared to 411 AAHUs under the baseline (no action) condition (Table 3). However, using the more directly comparable AAAHUs results from Tables 4 and 5, Alternative 1 would accrue 0.67AAAHUs/acre versus 0.36/acre under the baseline for a net gain of 0.31/acre; Alternative 2 would generate 0.57/acre versus 0.34 under the baseline for a net gain of 0.23/acre. Thus, overall, concept Alternative 1 would clearly be superior to concept Alternative 2.

Examining the AAAHU/acre results by measure and individual polygon (Table 5) yields several other findings as well: (1) the largest gains per acre would be derived by the relatively simple measure of improving the hydrologic connections of the two stranding pits to the river; (2) the next largest gains would accrue from creating new riparian forest habitat; (3) intermediate gains in value would occur from creating riparian oak woodland and oak woodland/savannah; and (4) the lowest gains per acre would result from conversion of existing ruderal area to grasslands.

In addition, Table 5 results show that within several of the measures, there would be differences in the gains per acre for different polygons of the same cover-type. Generally, the polygons with highest values would be those with improved hydrologic connections to the river or minimal amounts of existing high-value area that would have to be destroyed as part the cover-type re-creations.

This preliminary consideration of results has no consideration of costs. When costs are applied to the individual polygons within measures (as the Corps has done in deriving its best buy alternatives for each site), significant changes in preferred options, as based on the habitat-value results alone, may occur.

There are several restoration constraints not factored into the HEP analysis for this site. First, any alternative ultimately recommended for implementation should have at least the 63 acres of grassland designed into concept Alternative 1. We believe this is the minimum necessary to ensure adequate foraging area for the raptors which currently use the site, plus the expected *increase* of raptors using the site following restoration. This is a critical need, because the nearest alternate foraging areas for raptors are at least several miles away. Without ensuring adequate on-site foraging area, habitat value gains that would otherwise accrue to raptors in response to forest and wetlands re-creation might not be achieved. And thus some of the HEP accounting findings and conclusions would be invalidated.

Another constraint relates to the relatively low unit-value gain of 0.15 AAAHUs/acre (Table 5) that would be associated with converting existing ruderal area to grassland. An important constraint could not be factored into the HEP accounting, which is that it has been shown that yellow starthisle infestations can reduce wildlife habitat and forage, displace native plants, and decrease native plant and animal diversity. Dense infestations such as presently occur at the Woodlake site also threaten natural ecosystems and nature reserves by fragmenting sensitive plant and animal habitats. Thus, decisions as to whether to vigorously pursue conversions of the starthislte-dominated ruderal land to grassland at the site must consider these ecosystem-related constraints in addition to projected habitat-value gains and monetary costs.

Table 3. Average Annual Habitat Units (AAHUs), Woodlake Restoration Site, with new (to be created) values in bold.

COVER-TYPES PROPOSED TO BE CREATED	AAHUs BASELINE					AAHUs ALTERNATIVE 1					AAH	
	CA Vole	Owl FV	Owl CRV	SFCM	Total	CA Vole	Owl FV	Owl CRV	SFCM	Total	CA Vole	Owl FV
Seasonal Wetland	9.32	9.32	0	0	18.64	**6.19**	**6.55**	**0.01**	**2.24**	**14.99**	**12.12**	**13.30**
Seasonal Wetland "Pits"	3.61	2.57	4.30	2.43	12.91	**4.49**	**3.54**	**7.29**	**7.05**	**22.37**	**4.49**	**3.54**
Seasonal Wetland/Shrub	2.09	2.84	0.75	0	5.68	0	0	0	0	0	0	0
Subtotal Wetland Types	15.02	14.73	5.05	2.43	37.23	**10.68**	**10.09**	**7.30**	**9.29**	**38.31**	**16.61**	**16.84**
Riparian Forest	1.68	1.97	1.68	0	5.33	**33.68** 1.68	**39.46** 1.97	**32.44** 1.68	**0** 0	**105.58** 5.33	**19.31** 1.68	**22.80** 1.97
Riparian Forest/Wetland	13.87	14.64	11.08	0	39.59	13.87	14.64	11.08	0	39.59	13.87	14.64
Mixed Riparian Forest	28.19	31.10	28.88	0	88.17	25.47	28.10	26.09	0	79.66	26.56	29.30
Riparian Oak Woodland	6.72	11.00	4.28	0	22.00	**13.50** 6.72	**14.42** 11.00	**5.01** 4.28	**0** 0	**32.93** 22.00	**13.32** 6.72	**14.23** 11.00
Oak Woodland/Savannah	3.14	2.56	0	0	5.70	**40.20** 2.73	**43.05** 2.23	**14.97** 0	**0** 0	**98.22** 4.96	**23.99** 2.73	**25.69** 2.23
Mature Trees	0.64	0.71	0.11	0	1.46	0	0	0	0	0	0	0

Cottonwoods	1.05	1.41	0.14	0	2.60	0	0	0	0	0	0	0	0	0	0
Black Locust Grove	0.20	0.22	0.33	0	0.75	0.20	0.22	0.33	0	0.75	0.20	0.22	0.33	0	0.75
Subtotal Forest Types	55.49	63.61	46.50	0	165.60	**87.38** 50.67	**96.93** 58.16	**52.42** 43.46	**0** 0	**236.73** 152.29	**56.62** 51.76	**62.72** 59.36	**32.85** 44.58	**0** 0	**152.19** 155.70
Ruderal (Grasses/Thistle)	100.99	105.93	0	0	206.92	0.27	0.29	0	0	0.56	1.41	1.48	0	0	2.89
Grassland	0	0	0	0	0	**58.29**	**59.46**	**0**	**0**	**117.75**	**86.71**	**88.46**	**0**	**0**	**175.17**
Shallow Aquatic	0	0	0	0	0	**1.03**	**1.09**	**0**	**0.78**	**2.90**	0	0	0	0	0
Existing Elderberry Plants	0.36	0.40	0	0	0.76	0.36	0.40	0	0	0.76	0.36	0.40	0	0	0.76
TOTAL	171.86	184.67	51.55	4.95	410.51	**157.38** 51.30	**167.57** 58.85	**59.72** 43.46	**10.07** 0	**395.69** 153.61	**159.94** 53.54	**168.02** 61.24	**40.23** 44.58	**7.05** 0	**375.24** 159.36
GRAND TOTAL	171.86	184.67	51.55	2.43	410.51	208.68	226.42	103.18	10.07	549.30	213.48	229.26	84.81	7.05	534.60

Table 4. Total baseline (without project) habitat values derived from the HEP for the Woodlake restoration site, by cover-type and evaluation species.

COVER-TYPE	ACRE	CA VOLE			OWL FV			OWL CRV			SFCM			SUM Adj. AAHU	Adj. AAHU PER ACRE
		AAHU	RVI	Adj. AAHU	AAHU	RVI	Adj. AAHU	AAHU	RVI	Adj. AAHU	AAHU	RVI	Adj. AAH		
Seasonal Wetland	10.96	9.32	0.2	1.86	9.32	0.3	2.80	0	0.4	0	0	1.0	0	4.66	0.43
Seasonal Wetlnd Pits	6.94	3.61	0.2	0.72	2.57	0.3	0.77	4.30	0.4	1.72	2.43	1.0	2.43	5.64	0.81
Subtotal Wetlands	17.90	12.93	0.2	2.59	11.89	0.3	3.57	4.30	0.4	1.72	2.43	1.0	2.43	10.30	0.58
Riparian Scrub	4.18	2.09	0.2	0.42	2.84	0.3	0.85	0.75	0.4	0.30	0	1.0	0	1.57	0.38
Riparian Forest	2.37	1.68	0.2	0.34	1.97	0.3	0.59	1.68	0.4	0.67	0	1.0	0	1.60	0.68
Riparian Forest / Wetland	20.91	13.87	0.2	2.77	14.64	0.3	4.39	11.08	0.4	4.43	0	1.0	0	11.59	0.55
Mixed Riparian Forest	44.43	28.19	0.2	5.64	31.10	0.3	9.33	28.88	0.4	11.55	0	1.0	0	26.52	0.60
Riparian Oak Woodland	12.20	6.72	0.2	1.34	11.00	0.3	3.30	4.28	0.4	1.71	0	1.0	0	6.35	0.52
Oak Woodlnd / Savannah	4.42	3.14	0.2	0.63	2.56	0.3	0.77	0	0.4	0	0	1.0	0	1.40	0.32
Mature Trees	0.99	0.64	0.2	0.13	0.71	0.3	0.21	0.11	0.4	0.04	0	1.0	0	0.38	0.38
Cottonwds	1.71	1.05	0.2	0.21	1.41	0.3	0.42	0.14	0.4	0.06	0	1.0	0	0.69	0.40
Black Locust Grove	0.38	0.20	0.2	.04	0.22	0.3	0.07	0.33	0.4	0.13	0	1.0	0	0.24	0.63
Subtotal For. Types	91.59	57.58	0.2	11.52	66.45	0.3	19.94	47.25	0.4	18.90	0	1.0	0	50.36	0.55
Ruderal	163.54	100.99	0.2	20.20	105.93	0.3	31.78	0	0.4	0	0	1.0	0	51.98	0.32
Elderberry Plants	0.77	0.36	0.2	0.07	0.40	0.3	0.12	0	0.4	0	0	1.0	0	0.19	0.25
GRAND TOTAL	273.80	171.86	0.2	34.37	184.67	0.3	55.40	51.55	0.4	20.62	2.43	1.0	2.43	112.83	0.41

Table 5. Adjusted (by RVIs) habitat values from HEP for the Woodlake site, based on "measures" in the alternatives. (See text for discussions of RVIs and AAAHUs.)

MEAS NO.	COVER-TYPE(S) PROPOSED TO BE CREATED	ACRES	TOTAL AAAHUs						
			No Action	Alt. 1	Net Gain	Gain/ Acre	Alt. 2	Net Gain	Gain/ Acre
7	Riparian Forest - (RIP2)	15.73	5.86	11.91	6.05	0.38	-	-	-
		14.51	5.26	-	-	-	10.79	5.53	0.38
	Riparian Forest - (RIP3)	4.76	1.93	4.67	2.74	0.58	-	-	-
		4.79	1.94	-	-	-	4.70	2.76	0.58
8	Riparian Oak Woodland -(ROW1)	5.99	1.90	3.27	1.37	0.23	-	-	-
		4.98	1.58	-	-	-	2.72	1.14	0.23
	Riparian Oak Woodland -(ROW2)	11.37	3.61	6.21	2.60	0.23	-	-	-
		11.16	3.54	-	-	-	6.09	2.55	0.23
9	Oak Woodland / Savannah -(OWS1)	13.20	4.19	7.21	3.02	0.23	-	-	-
		8.42	2.67	-	-	-	4.60	1.93	0.23
	Oak Woodland / Savannah -(OWS2)	16.89	5.36	9.10	3.74	0.22	-	-	-
		9.10	2.89	-	-	-	4.82	1.93	0.21
	Oak Woodland / Savannah -(OWS3)	18.64	5.92	9.65	3.73	0.20	-	-	-
		11.55	3.67	-	-	-	5.78	2.11	0.18
10	Grassland -(GR1)	62.64	19.91	29.47	9.56	0.15	-	-	-
		93.18	29.62	-	-	-	43.84	14.22	0.15
13 possible project feature*	Shallow Aquatic - (SAQ1)*	1.16	0.55	1.32	0.77	0.66	-	-	-
	Seasonal Wetland - (SW1)*	3.34	1.36	3.78	2.42	0.72	-	-	-
	Riparian Forest - (RIP1)*	27.75	13.19	29.84	16.65	0.60	-	-	-
16	Improve Wetl. "Pit" - (SW3)	5.57	2.98	7.99	5.01	0.90	-	-	-
	Improve Wetl. "Pit" - (SW4)	3.07	1.59	4.24	2.65	0.86	-	-	-
	Improve Wetl. "Pit" - (SW2)	5.57	2.98	-	-	-	7.99	5.01	0.90
	Improve Wetl. "Pit" - (SW3)	3.07	1.59	-	-	-	4.24	2.65	0.86
4	Seasonal Wetland - (SW2)	2.61	1.14	1.24	0.10	0.04	-	-	-
	Seasonal Wetland - (SW1)	14.35	5.54	-	-	-	6.45	0.91	0.06
6	Riparian Forest - (RIP1)	8.48	2.70	-	-	-	5.54	2.84	0.33
ALTERNATIVE 1 - TOTAL		192.72	69.49	129.90	60.41	0.31	-	-	-
ALTERNATIVE 2 - TOTAL		189.16	63.98	-	-	-	107.56	43.58	0.23

A final constraint involves the need for diversity and functioning improvements achieved through cover-type mixing to ensure a complex mosaic pattern of habitat. This is yet another ecosystem-related issue that the HEP accounting addressed in only a limited manner through the species models that were selected. Our position is that any alternative recommended for implementation should involve re-creation of the same general type of cover-type mix as was included and evaluated in the two preliminary concept design alternatives. Biodiversity and ecosystem-functioning improvements can best be assured with such a mix. The primary focus of the restoration of this site is, and should remain, the re-creation of various floodplain and riparian forest habitats.

Conclusions: Preliminary Concept Design Alternatives

The Service would likely endorse implementation of either concept Alternative 1 or Alternative 2, as currently designed, or any other materially and significantly similar alternative as the Corps may develop by combining the measures and polygons (or similar polygons) evaluated herein.

Within Alternative 1, measures 16, 13, and 7 (particularly the RIP3 polygon), in that order, would create the highest rates of habitat-value gain. Under Alternative 2, measures 16 and 7 (particularly RIP3), in that order, would have the highest rate of habitat-value gain (Table 5).

Of the two concept design alternatives, Alternative 1 would be clearly superior to Alternative 2.

In any restoration alternative recommended for implementation, not less than 63 acres of the site's ruderal area should be restored to native grassland.

Conclusions: Corps' Currently Recommended Plan

Subsequent to the Service's analysis presented above for the two concept design alternatives, the Corps and JSA used Corps planning principles and guidelines, and incremental cost analyses, to develop a "best buy" plan for the Woodlake restoration site. This best buy plan is called the "recommended plan" in the accompanying Corps environmental document. JSA Plate X shows the design and locations of the recommended plan's restoration measures.

The Service has determined that the recommended plan is materially and significantly similar to concept design Alternative 2. The only slight differences between the two are the small differences in acreages of certain polygons and the fact that only the larger of the two stranding pits (instead of both stranding pits) would be reconnected to the river under the recommended plan.

The recommended plan would thus generally achieve the goals established for both the restoration effort in general and for the HEP at this distinct restoration site. In particular, significant new riparian habitat structure and ecosystem process functioning would be established. Existing habitat values for raptors would be preserved and new raptor habitat values would be created. Negative impacts to existing high-value habitat areas would be comparatively small. The potential for detrimental impacts to federally listed terrestrial species, including the valley elderberry longhorn beetle (VELB), would be relatively low. Improvements to habitat values for listed aquatic species, including Central Valley steelhead, delta smelt, and Sacramento splittail, would occur. In this manner, the restoration effort would contribute to these species' recovery.

The Service supports implementation of the recommended plan for the Woodlake site, subject to the "Recommendations Relative to the Five Restoration Options" given later within this report.

II. URRUTIA SITE

Location and General Description

The Urrutia site (*see* JSA Plate 2) is a privately owned sand and gravel mining operation located along the north bank of the American River roughly adjacent to RM 1 and 2. The site is slightly smaller than the Woodlake site, but has a similar origin–a high-terrace floodplain formed during the 1800s from extensive hydraulic mining debris deposits washed down the river. The site is bounded: on the east by Northgate Boulevard; on the west by Discovery Park; on the north by Bannon Slough and the American River Parkway bicycle path; and on the south by the river. The total area within these boundaries is about 242 acres.

Cover-Type Delineations and Mapping

Mapping of the cover-types of the site was completed by JSA the same as for the Woodlake site. A combination of aerial photographic interpretation and ground-truthing was employed and the information entered into a GIS data base. Then, separate maps for existing conditions and each of two preliminary concept design alternatives (*see* footnote 1 above for the Woodlake site) were created. The maps included topographic contour lines and were based on aerial photography of the river corridor acquired by the Corps in 1997.

Cover-Type Acreages

JSA provided acreages on the maps for most of the mapped polygons. These were generated using appropriate GIS software. In the few instances where acreages were not provided, they were measured by a Service technician or biologist using an electronic planimeter. Table 6 summarizes the acreages for baseline conditions and each of the two concept design alternatives. The problem of reconciling acreages among the three maps as described for the Woodlake site did not occur and do not have to be addressed for the Urrutia site.

Existing Cover-Types and Conditions

Barren. Barren area, the largest cover-type of the area at 71.0 acres, is predominantly bare ground which has been degraded and compacted by the sand and gravel mining operations. Sparse patches of herbaceous vegetation, including annual grasses and various weed species, occur in the less degraded and compacted portions.

Open Water. The second largest cover-type of the site is the 62.4 acres of open water in the pit where sand and gravel have been extracted for many years. This pit is estimated to be 25-30 feet deep. It has steep (varying 1:1 to 2:1) existing bank slopes which are mostly unvegetated, except for occasional small patches of herbaceous vegetation, mainly annual grasses.

Ruderal. The high-terrace area adjacent to the open water pit in the northeasterly portion of the site was classified by JSA as "annual grasses." Just as for the Woodlake site, we have identified this area as ruderal. The ruderal area makes up 34.1 acres and is comprised of various herbaceous species, including grasses. Non-native invasive species, including yellow starthistle, Russian thistle, and cocklebutt, are also present. However, yellow starthistle occurs relatively sparsely, unlike its overwhelming dominance at the Woodlake site.

Riparian Forest/Permanent Wetland. The area along Bannon Slough is a moderately high-value riparian forest and permanent wetland complex comprising 25.4 acres. This cover-type extends along the entire northern perimeter of the site. The parkway bicycle path currently runs along the edge of the riparian forest strip which borders the slough. The slough has year-round flows from the Natomas East Main Drain and hence from several streams and drainages which extend well into the foothills east of Sacramento. Several of these foothill streams are known to support anadromous salmonids.

Oak/Cottonwood Forest. The southeastern corner of the site is composed of a 21.8-acre oak/cottonwood forest. This forest area has moderate-to-high values, due to large, mature trees and generally good understory cover consisting of both herbaceous and woody species. Elderberry shrubs are among the more common woody species.

Boy Scout Camp. A 15.6-acre private parcel adjacent to the oak/cottonwood forest is currently leased to and used by the Boy Scouts of America. This parcel has large trees similar to the oak/cottonwood forest, but because it lacks understory and has a park-like setting, it thus has much less fish and wildlife habitat value than the adjacent oak/cottonwood forest.

Table 6. Acreages by cover-types, of the Urrutia restoration site, for Baseline, Alternative 1, and Alternative 2. Bolded figures are acreages to be *created*, with actual net increases of new area in parentheses. Letter-number codes refer to specific mapped polygons.

	ACREAGES

COVER-TYPE(S)	BASELINE	ALTERNATIVE 1	ALTERNATIVE 2
Seasonal Wetland	0	**SW1-0.59** (0.59)	**SW1-7.63** (7.63)
Emergent Wetland	0	**EW1-6.47** (6.47)	**EW1-3 -4.61** (4.61)
Open Water	62.36	59.18	34.11
Riparian Forest/Shrub	2.15	**RF01-7.77** (7.77) **RF02-67.31** (65.76) **RFO3 -1.78** (0.81)	**RFO1-7.77** (7.77) **RFO2-78.31**(78.31) **RFO3-0.70** (0) **RFO4-0.75** (0)
Riparian Forest/Permanent Wetland	25.42	25.42	25.42
Riparian Oak Woodland	0	**ROW1-4.35** (4.35)	**ROW1-10.70** (10.70)
Boy Scout Camp (Urban Forest)	15.62	15.62	15.62
Oak/Cottonwood Forest	21.80	21.80	21.80
Cottonwoods	5.62	5.62	5.62
Young Cottonwoods	1.55	0	0
Shallow Aquatic	0	**SAQ1-0.59** (0.59)	**SAQ1-1.56** (1.56)
Shaded Riverine Aquatic	0.76	0	0
Grassland	0	**GR1-6.53** (6.53)	**GR1-2-9.51** (9.51)
Barren (Degraded/Compacted)	71.00	0	0
Ruderal	34.08	18.55	17.47
Developed	1.98	0	0
TOTAL	241.58	241.58 (92.87)	241.58 (120.09)

Other Cover-Types. Several other cover-types with low-to-moderate existing habitat values occur on the site as follows: two small patches of cottonwoods totaling 5.6 acres on the western edge of the site next to the open water pit; a 1.6-acre strip of young cottonwoods in the ruderal area along a shallow overflow channel which receives periodic seasonal flooding from Bannon Slough; a 2.2-acre strip of riparian forest/shrub ("riparian vegetation" per JSA Baseline Plate) along the riverside border of the site; and an 0.8-acre area of Shaded Riverine Aquatic (SRA) cover located in the nearshore area adjacent to the 2.2-acre riparian forest/shrub strip. This SRA cover would be heavily impacted by one of the measures in each of the two concept design alternatives; such losses would be of particular concern to the Service, because such SRA cover of the lower Sacramento River System has, since 1992, been designated as Resource Category 1 habitat under the Service's Mitigation Policy.

Infrastructure. The site has a network of unimproved and graveled roads that have been used during the sand and gravel mining operations. In addition, several utility lines traverse the eastern and northern portions of the site via about nine large, metal towers. Also, about 2.0 acres on the western edge of the site adjacent to the open water pit are developed and utilized by the mining operators as a residence, equipment, and out-building area. The owner's residence, a single-family dwelling, is elevated 10-15 feet to reduce flooding during high river stages.

Existing Wildlife Usage and Values

Overall, wildlife usage and values of the Urrutia site are much lower than for the Woodlake site. In particular, the large barren area has little or no significant values due to the highly compacted substrate and lack of vegetative cover. The oak/cottonwood forest, which might otherwise support significant fish and wildlife usage, is relatively small and degraded by trash, debris and human activity associated with homeless-person encampments. The Boy Scout camp area is similarly reduced in value by lack of understory and frequent human disturbance. The ruderal area of the site does provide high-value cover for various small- and mid-sized mammals and certain birds, but this ruderal patch is much smaller than the ruderal area at the Woodlake site, which receives very high usage by raptors.

The highest-value cover-type at the site is probably the riparian forest/permanent wetland along the northern border. However, this area too is negatively impacted by human disturbance–both from the adjacent bicycle path and from heavy vehicular traffic along the Garden Highway, which is atop the main river levee along the north side of Bannon Slough.

The open water area of the site is suspected of being a source of fish stranding, just as for the two stranding "pits" located on the Woodlake site. However, there are no studies or data to confirm such a problem.

On the other hand, the open water area of the mining pit does have significant benefits as a loafing and resting area for various waterbirds. Most loafing and resting use occurs towards the center area of the pit, probably because of the general lack of any buffering cover around the shoreline or on the barren zone adjacent to it. A wide array of waterbirds has been observed loafing and resting, but gulls and diving ducks are clearly the most abundant. Based on recent limited observations by Service biologists, at peak periods during winter and early spring, up to several hundred bird-days of usage occur daily. Several species of dabbling ducks also utilize both the open water and the shallower perimeter areas of the pit for feeding and resting. However, the value of the shoreline of the pit for reproduction by waterbirds, including dabbling ducks, is virtually nonexistent due to the lack of vegetative cover.

The site has low-to-moderate use by raptors. But both diversity and density of raptors are much lower than for the Woodlake site. During several visits to the Urrutia site during December 2000-February 2001 Service biologists recorded only four total species of raptors. The most common species was the red-tailed hawk which was observed foraging from perches in large trees and from atop utility towers located on the site. Raptor use of the site appears to be only modest, at best, probably due to relatively low prey availability. This in turn is due to lack of cover, with a large part of the site being in a barren or sparsely vegetated condition. Only about 34 acres–the existing ruderal area–provide good-quality habitat for raptor prey populations.

Qualitatively, in terms of overall existing fish and wildlife habitat value, and judged on a scale of 1(lowest) to 5 (highest), our best professional judgement is that the Urrutia site would rate about a 2. In comparison and with the same scale, the Woodlake site would rate a 5. This subjective comparison suggests that there could be considerably more restoration potential (in terms of possible habitat-value gain per unit area) at the Urrutia site than at the Woodlake site. One role of the HEP applications for the sites is to more objectively evaluate this issue.

Alternatives Evaluated

Just as for the Woodlake site, JSA developed two concept design restoration alternatives for this site. Alternative 1 would be the more conservative and less costly approach involving 95.4 acres (Tables 6 and 7). It would entail (1) restoring barren and ruderal areas to (mainly) riparian forest, riparian oak woodland, and grassland; and (2) establishing a 25-foot-wide band of emergent wetland around the entire perimeter of the open water pit. In the process, the open water pit would be reduced slightly in size from 62.4 to 59.2 acres.

Alternative 2 would be the more aggressive and costly action, involving changes on 121.5 acres (Tables 6 and 7). It would result in (1) larger restored acreages of (mostly) riparian forest, riparian oak woodland, and grassland; (2) slightly less emergent wetland located in three small “patches” around the pit perimeter, instead of contiguously around the entire perimeter; and (3) a seasonal wetland/shallow aquatic habitat complex which would be hydrologically connected to the river. These features would result in the open water area of the pit being reduced from 62.4 to 34.1 acres.

Both alternatives would also include significant changes to the 2.2-acre strip of riparian forest/shrub (“riparian vegetation” on JSA Baseline Plate) and its associated 0.8-acre strip of adjacent SRA cover along the waterside border of the south side of the site. Presently, this habitat is relatively steep, sparsely vegetated, and lacking in woody species reproduction. It has

Table 7. Measures, cover-types, and polygons evaluated using HEP for two preliminary conceptual alternatives at the Urrutia site, LAR.

ALT	MEASURE(S)	COVER-TYPE(S) AND POLYGON(S)	ACRES
1	7	Riparian Forest-RFO1 Riparian Forest-RFO2	7.77 67.31

	15	Riparian Forest-RFO3 +Shallow Aquatic-NA +Seasonal Wetland-NA	1.78 (60%2.96) 0.59 (20%2.96) 0.59 (20%2.96)
	17	Emergent Wetland-EW1	6.47
	8	Riparian Oak Woodland-ROW1	4.35
	10	Grassland-GR1	6.53
	ALTERNATIVE 1 TOTAL		95.39
2	7	Riparian Forest-RFO1 Riparian Forest-RFO2	7.77 78.31
	15	Riparian Forest-RFO3-4 +Shallow Aquatic-NA +Seasonal Wetland-NA	1.45 (60%2.41) 0.48 (20%2.41) 0.48 (20%2.41)
	17	Emergent Wetland-EW1-3	4.61
	8	Riparian Oak Woodland-ROW1	10.70
	10	Grassland-GR1-2	9.51
	13	Seasonal Wetland-SW1 Shallow Aquatic-SAQ1	7.15 1.08
	ALTERNATIVE 2 TOTAL		121.54

also been significantly degraded by the placement of broken concrete slabs and waste material along the bank for bank protection. In both concept design alternatives, a portion of the existing shoreline and upper bank length along the river would be cleared, reshaped, and regraded to restore a more natural riparian hydrologic regime. This would result in the appropriate hydrology for planting and establishing (at decreasing elevations) new, high-value, self-sustaining riparian forest, shallow aquatic and seasonal wetland cover-types.

Measures

The two concept design alternatives would make use of 7 of the 25 total restoration measures, as follows:

! *Measure 6*–Plant riparian forest species;

- *Measure 7*–Grade the floodplain and create appropriate hydrology to support riparian forest species, and plant riparian forest species;

- *Measure 8*–Plant riparian oak woodland species;

- *Measure 10*–Seed and establish grassland;

- *Measure 13*–Modify hydrology and construct side-channels off the main river and plant shallow aquatic, seasonal wetland, and riparian forest species (except no riparian forest species in this instance);

- *Measure 15*–Terrace steep, degraded river banks and plant with riparian forest species (except in this instance, a portion of the terraced area would actually be converted to shallow aquatic (20%) and seasonal wetland (20%) habitat); and

- *Measure 17*–Construct low-elevation bank benches in interior open waters and plant with emergent wetland species.

The relationships of the measures to alternatives and to specific cover-types and polygons are shown in Table 7.

Goals Governing the HEP Application

Just as for the Woodlake site, an overriding goal shared by agencies party to this evaluation is the restoration of significant ecosystem function, structure, and dynamic processes that have been degraded along the LAR system. Achieving this goal may entail restoring diverse native plant communities and habitats, improving connectivity and functionality between habitats, re-creating hydrologic interaction between the river and its floodplain areas, and reducing potential for fish stranding in unnatural or adversely modified floodplain areas. These potential actions were incorporated to the degree practicable for this particular site using the seven measures listed above.

In addition, the Service adopted five site-specific goals, based on existing site-specific conditions at the Urrutia site, which governed how the HEP was designed, conducted and interpreted: (1) to preserve or improve overall fish and wildlife habitat values to the extent feasible; (2) to improve raptor values; (3) to minimize the areal extent of any SRA cover losses, and limit such losses to actions which would create other new habitats with equal or higher ecosystem functioning value; (4) to ensure that any SRA cover losses are fully offset in terms of habitat value; and (5) to improve habitat values for adult and juvenile Sacramento splittail, and juvenile salmonids.

HEP Team

The HEP team composition and utilization by the Service for this HEP application followed that of the Woodlake site. Refer to that discussion for details.

HEP Overview

The first step was to identify and enumerate the various mapped polygons for each of the two alternatives by measure and cover-type (Table 7). This provided a foundation for the same type of analysis as was completed for the Woodlake site, and ensured that the Corps would have results in a form to facilitate incremental analyses and development of other alternatives, including a “best buy” alternative.

Most of the cover-types at the Urrutia site were the same as (or very similar to) the Woodlake site. Thus, all of the evaluation species and HSI models (and their associated SIs) for Woodlake (*see* Table 2) were also applicable for use in the Urrutia site HEP.

However, three aspects of the Urrutia site HEP were different from the Woodlake site HEP: (1) a new cover-type–open water–of the large mining pit, around (and within) which the restoration would be focused; (2) another new cover-type–emergent wetland–that would be created; and (3) the SRA cover along the river bank that would be impacted.

For tracking habitat values associated with SRA cover, open water and emergent wetland, appropriate evaluation species and HSI models were required. SRA cover values were tracked using the Service’s existing community-based, HSI model for this cover-type (Appendix A). Thus, SRA cover became another evaluation species in the analysis. For both open water and emergent marsh, simple HSI models meeting the design needs of the HEP were not available. Thus, for each of these cover-types, a brief new community-type model was developed (Appendix A) and used as an evaluation species in the HEP application. The open water model was referred to as evaluation species OWM, while the emergent marsh model was abbreviated as EMM throughout the analysis.

Sampling and Variable Measurement Methods

For those evaluation species that were the same as used at the Woodlake site (i.e., vole, owl FV, owl CRV, and SFCM), the baseline condition sampling at Urrutia was done following the same general procedures as used at the Woodlake site. This field sampling was done during February 2001. The resulting baseline conditions are provided in Appendix B.

Field sampling to determine SRA cover baseline conditions could not be accomplished as needed during February 2001, because of high water surface elevation along the site. This was due mainly to backwater effect due to season-high flow stages on the Sacramento River at the Sacramento and American rivers confluence. Therefore, the SIs to derive the HSI for SRA cover that would be impacted were estimated by visually studying 35mm color photographs acquired along the site during December 2000. These photos were taken when the water surface elevation was substantially lower and more appropriate for SRA cover measurements. The resulting SRA cover baseline conditions are presented in Appendix B.

Because of model design, formal field sampling was not necessary for deriving HSIs for baseline conditions of the OWM and EMM evaluation species. Instead, two Service biologists just visually examined each site and then collaborated in mutually deriving the appropriate HSI value from the respective word model as given in Appendix A.

Mean Weighted HSIs

Mean weighted HSIs were calculated, with acreages as weighting factors, just as for the Woodlake site. However, far fewer mean HSIs had to be derived than for the Woodlake site, because it was determined that this approach was in fact more time-consuming and cumbersome than simply accounting separately in the HEP for all evaluation species across all cover-types, and then summing results as appropriate for particular areas of interest.

Futures Projections and HSI Derivations

Just as for the Woodlake site, numerous future variables had to be projected. The various concepts, assumptions and principles underlying the projections used to derive future SIs and HSIs are presented in Appendix C.

Target Years Used in the Analyses

Just as for the Woodlake site, the HEP accounting was based on a 50-year period of analysis.

HEP Output/Results

The HEP accounting results were generally derived, collated, and summarized the same as for the Woodlake site.

Relative Value Indices

For the four evaluation species carried over from the Woodlake site analyses, the same RVIs were used: SFCM-1.0; owl CRV-0.4; owl FV-0.3; and California vole-0.2. RVIs for the three added evaluation species were: SRA cover-1.0; EMM-0.4; and OWM-0.2.

SRA cover was assigned a maximum RVI of 1.0. This was because: it has very high value to listed fish which occur in the Sacramento River system; it is an important component of a healthy, optimally-functioning riverine ecosystem; and along the LAR it has been assigned the highest Resource Category (#1) designation possible under the Service's Mitigation Policy. Because SRA cover and seasonal floodplain habitat (SFCM) have the same RVI, habitat units of one could potentially be traded (or used to offset) for the other on a 1:1 basis.

An intermediate RVI of 0.4 for EMM habitat value was based on this cover-type supporting a relatively wide range of fish and wildlife types and species throughout the year. The cover-type also supports breeding as well as other life requisites of local fish and wildlife species. Thus, EMM is similar to owl CRV, which also was assigned an RVI of 0.4.

The OWM was given a relatively low RVI of 0.2 because this kind of habitat along the LAR has relatively limited fish and wildlife habitat values and functioning. In particular, it supports comparatively few species of just one group–water birds–and it generally provides value in terms of only resting or feeding, with little or no value for reproduction.

Results and Discussion

Preliminary results, in the form of a worksheet from which the AAAHUs were derived from AAHUs across all cover-types and polygons, are presented in Appendix D. These data were then consolidated into final format based on AAAHUs as shown below in Table 8.

As expected, results (Table 8) showed that despite the very similar measures and alternatives at the Woodlake and Urrutia sites, considerably more habitat value gains per unit area could be derived at the latter site. In particular, Alternative 1 at the Urrutia site would accrue 0.69AAAHUs/acre compared to 0.17/acre for the baseline (no action) condition, for a net gain of 0.52/acre. Alternative 2 would be very similar, accruing 0.68AAAHUs/acre compared to 0.16/acre for baseline, also for a gain of 0.52/acre. Thus, unlike the Woodlake site, neither one of the preliminary action alternatives at Urrutia would be clearly superior over the other in terms of habitat value gain/acre.

Under concept design Alternative 1, the three highest-gaining combinations of measure, cover-type, and polygon (in descending order) would be: (1) 7-riparian forest-RFO1 (1.19/acre); (2) 15-riparian forest-RFO3 (0.69/acre); and (3) 15-shallow aquatic-NA (0.68/acre) (Table 8). These same combinations would accrue essentially the same values under Alternative 2. In addition, in concept Alternative 2, the shallow aquatic (SAQ1) and seasonal wetland (SW1) areas that would be created under measure 13 would create relatively high gains of 1.10 and 0.83AAAHUs/acre, respectively.

In contrast, the lowest-gaining measures (in ascending order) would be the habitat conversions in both alternatives to grasslands (measure 10), riparian oak woodland (measure 8), and emergent wetland (measure 17).

Just as for the Woodlake analysis, these preliminary values give no consideration to costs. Applying costs to the measures, as the Corps has done to develop best-buy alternatives, may change rankings and preferences as indicated in the Table 8 results.

Another constraint is that in each of JSA's two concept design alternatives, the proposed acreage that would remain "open"–as either ruderal or grassland area–is likely insufficient. Total ruderal-grassland area would only be 25.1 or 27.0 acres, respectively, under Alternatives 1 and 2. Either figure is likely to be an insufficient size of area to support foraging raptors. Applying the same ratio we recommended above for the Woodlake site of at least 63.0 acres (23%) of grassland and/or ruderal for 273.8-acre area, the Urrutia site would need at least 55.6 acres (23% of 241.6 acres) of grassland and/or ruderal area. Moreover, it would be incongruous to expend significant public dollars creating such a massive forest restoration at the Urrutia site, for which one of the primary fish and wildlife beneficiaries would be raptors, without providing adequate foraging area for such species. This is especially true because alternate raptor foraging sites are likely several miles away from the Urrutia site.

A constraint of at least 56 acres of open ruderal and/or grassland foraging area at the Urrutia site may appear counter intuitive given the very low gain–only 0.02 AAAHUs/acre–that the HEP indicated would result from grassland creation (Table 8). However, part of the reason for such a low gain is that all three of the proposed grassland polygons in the two preliminary action alternatives were located within the existing ruderal area of the Urrutia site. This area already has relatively high values to its associated evaluation species. This is also the main reason that the riparian oak woodland re-creation measure rated rather low (0.10AAAHUs gain/acre) in both alternatives. Moving these polygons to currently barren areas would be expected to substantially increase the gains of habitat values that could be achieved under such actions. In fact, siting the

Table 8. Adjusted (by RVIs) habitat values from HEP for the Urrutia site, based on "measures" in the alternatives. (See text for site-specific RVI and AAAHU discussion.)

MEAS. NO.	COVER-TYPE(S) PROPOSED TO BE CREATED	ACRES	TOTAL AAAHUs						
			No Action	Alt. 1	Net Gain	Gain/ Acre	Alt. 2	Net Gain	Gain/ Acre
7	Riparian Forest (RFO1)	7.77	0.52	9.79	9.27	1.19	-	-	-
		7.77	0.52	-	-	-	9.79	9.27	1.19
	Riparian Forest (RFO2)	67.31	8.75	44.51	35.76	0.53	-	-	-
		78.31	7.62	-	-	-	50.92	43.30	0.55
8	Riparian Oak Woodland (ROW1)	4.35	1.98	2.40	0.42	0.10	-	-	-
		10.70	4.88	-	-	-	5.91	1.03	0.10

15	Riparian Forest (RFO3)	1.78	0.98	2.20	1.22	0.69	-	-	-
	Riparian Forest (RFO3-4)	1.45	0.80	-	-	-	1.79	0.99	0.68
	Shallow Aquatic - NA	0.59	0.27	0.67	0.40	0.68	-	-	-
	Shallow Aquatic - NA	0.48	0.22	-	-	-	0.55	0.33	0.69
	Seasonal Wetland - NA	0.59	0.27	0.67	0.40	0.68	-	-	-
	Seasonal Wetland - NA	0.48	0.22	-	-	-	0.55	0.33	0.69
10	Grassland (GR1)	6.53	2.97	3.08	0.11	0.02	-	-	-
	Grassland (GR1-2)	9.51	4.34	-	-	-	4.48	0.14	0.02
13	Shallow Aquatic (SAQ1)	1.08	0.02	-	-	-	1.21	1.19	1.10
	Seasonal Wetland (SW1)	7.15	0.51	-	-	-	6.47	5.96	0.83
17	Emergent Wetland (EW1)	6.47	0.25	2.2	1.95	0.30	-	-	-
	Emergent Wetland (EW 1-2)	4.61	0.37	-	-	-	1.37	1.00	0.22
ALTERNATIVE 1-TOTAL		95.39	15.99	65.52	49.53	0.52	-	-	-
ALTERNATIVE 2-TOTAL		121.54	19.50	-	-	-	83.04	63.54	0.52

grasslands in currently barren areas would be expected to generate more than the 0.15/acre gain projected for the Woodlake site's proposed conversions from ruderal to grassland.

Conclusions: Preliminary Concept Design Alternatives

The Service would likely endorse implementation of either concept design Alternative 1 or Alternative 2, as currently designed, or any other materially and significantly similar alternative as the Corps may develop by combining the measures and polygons (or similar polygons) evaluated herein.

Within both concept design Alternatives 1 and 2, measures 7 (RFO1) and 15 (all three proposed cover-types), in that order, would create the highest gains of habitat value per acre.

Of the two concept design alternatives, neither would be clearly superior to the other. However, both would generally be superior to the two concept design alternatives for the Woodlake site, at least in terms of projected habitat-value gains per acre as measured by HEP.

In any restoration alternative recommended for implementation, not less that 56 acres of the Urrutia site's ruderal area should be converted to grassland.

Conclusions: Corps' Currently Recommended Plan

Subsequent to the Service's analysis presented above for the two concept design alternatives, the Corps and JSA used Corps planning principles and guidelines, and incremental cost analyses, to develop a "best buy" plan for the Urrutia restoration site. This best buy plan is called the "recommended plan" in the accompanying Corps environmental document. JSA Plate X shows the designs and locations of the various restoration measure polygons for the Urrutia site under the recommended plan.

The Service has determined that the recommended plan is materially and significantly similar to concept design Alternative 2. The only slight differences between the two are the small differences in design and acreage of certain of the proposed habitat polygons. Differences in acreages are generally 10 % or less.

The recommended plan would thus generally achieve the goals established for both the restoration effort in general and for the HEP at this distinct restoration site. In particular, a relatively large amount of new riparian habitat structure and ecosystem process functioning would be established. Losses of SRA cover would be minimized, fully offset in value, and generally limited to areas where the new cover-types being created would soon have higher habitat and ecosystems functioning values than now. Negative impacts to existing high-value habitat areas would be almost nonexistent. The potential for detrimental impacts to federally listed terrestrial species, including the VELB, would be extremely low or nonexistent. Improvements to habitat values for listed aquatic species, including Central Valley steelhead, delta smelt, and Sacramento splittail, would be large and significant. In this manner, the restoration effort would be expected to contribute very substantially to these species' recovery.

For raptors, existing habitat values would be preserved and new habitat would potentially be created. However, the new raptor habitat might not achieve full value and functioning, due to the relatively small amount (10.0 acres) of grassland area that would be created. As indicated in the preceding section, the Service recommends that at least 56 acres of grassland or similar "open" raptor foraging habitat be provided.

The Service strongly supports implementation of the recommended plan for the Urrutia site, subject to (a) appropriate design modification which would provide for the minimum 56-acres of grassland area; and (b) the other "Recommendations Relative to the Five Restoration Options" presented later within this report.

III. BUSHY LAKE SITE

Location and General Description

The Bushy Lake site (*see* JSA Plate 6) is a large, publically owned (Parkway and Cal Expo) parcel just south of the Cal Expo (California State Fair) grounds and facilities. It is roughly adjacent to RMs 4.0 to 5.5 of the American River. The site is on the opposite side of the river from Paradise Beach, a popular recreational beach along the river. The site is larger than either the Woodlake or Urrutia sites, but has a similar origin–a high-terrace floodplain formed during the 1800s from extensive hydraulic mining debris which washed down the river. The site is bounded: on the east by a concrete inflow channel which receives water pumped by the City into the river from Chicken and Strong Ranch sloughs; on the north by Cal Expo grounds and facilities; on the west by Business (Capital City Freeway) Highway 80; and on the south by the river. Total area within these boundaries is about 343 acres.

Cover-Type Delineations and Mapping

Mapping of the cover-types of the site was completed by JSA the same as for the other sites. A combination of aerial photographic interpretation and ground-truthing was employed and the information entered into a GIS data base. Then, separate maps for existing conditions and each of two concept design restoration alternatives (*see* footnote 1 above for the Woodlake site) were created. The maps included topographic contour lines and were based on aerial photography of the river corridor acquired by the Corps in 1997.

Cover-Type Acreages

JSA provided acreages on the maps for most of the mapped polygons. These were generated using the GIS software. In the few instances where acreages were not provided, they were measured by a Service technician or biologist using an electronic planimeter. The problem of reconciling acreages among the three maps for the site (as encountered for the Woodlake site) was not an issue for the Urrutia site.

Existing Cover-Types and Conditions

The name of the site is derived from its central feature–Bushy Lake. Bushy Lake is a shallow, mostly open water body comprising about 12.2 acres on the north-central portion of the site. This lake was originally created by borrow operations for nearby levee construction and repair. The lake has high wildlife values, especially for waterbirds. Lake levels are maintained to prescribed standards as prescribed in the Bushy Lake Protection Act. In summer, ground water is pumped to maintain a minimum lake level; during winter, significant volumes of storm drainage water are pumped into the area. During seasonally wet periods, the size of the lake often more than doubles. Large, standing cottonwood snags, which are the remnants of an intense fire several years ago, are scattered throughout the lake and adjacent seasonal floodplain area.

Other noteworthy habitat elements of the site include: 66.0 acres of riparian forest/scrub-shrub seasonal floodplain bordering the river along the westerly two-thirds of the site; 10.7 acres of mostly bare ground in the northeast corner, which is seasonally used for overflow vehicle parking from Cal Expo; 2.7 acres of oak/ash/black locust woodland near the Chicken and Strong Ranch sloughs outlet; 6.5 acres of riparian forest/permanent wetland along the northwest border of the site; 16.7 acres of willow/cocklebur shrub in patches along the south side of the lake; several small patches of willows and oaks totaling about 3.1 acres; two patches of giant cane which total 1.2 acres along the river in the central portion of the site; a 2.3-acre riparian forest grove along the north side of Bushy Lake which is referred to as "picnic island" due to the presence of a picnic table; a 1.3-acre patch of sweet fennel and yellow starthistle in the eastern corner; and about 6.0 acres of ruderal area occurring in scattered patches over the site.

An additional important cover-type at the site is SRA cover. SRA cover occurs along the shoreline starting near the Chicken and Strong Ranch sloughs outlet confluence with the river and extends southwesterly downstream about 2,500 feet along the border of the site. This SRA cover is about 10 feet in width, thus the total SRA cover area is about 0.6 acre. Much of the bank adjacent to this SRA cover is steep and eroding. Nevertheless, this SRA cover has moderately high existing values, due to moderate amounts of overhanging vegetation, in-stream large and small woody debris, hydraulic diversity, and cover in the form of undercut and eroding banks. All SRA cover of the lower Sacramento River system, including the LAR, has been classified by the Service as Resource Category 1.

In terms of acreage, however, by far the largest single cover-type of the site is the 227 acres of tree and shrub savannah. Trees are predominantly widely scattered oak and black walnut. Shrubs include mainly coyote bush and elderberry. However, elderberry is overwhelmingly dominant. In fact, there are dozens, if not hundreds, of large, mature elderberry plants well distributed throughout the area. Elderberries are the host plant for the federally threatened valley elderberry longhorn beetle. The savannah has ground cover composed mostly of annual grasses and other herbaceous plants. Yellow starthistle is limited to a few small patches totaling a few acres.

Like the Woodlake and Urrutia sites, the Bushy Lake site has a network of unimproved roads accessible during the dry season. In addition, like the other sites, several large-capacity power transmission lines atop high metal towers traverse the site–mostly across the northern half. The site is also reportedly crossed by several underground utility cables. The site does not have any buildings or other above-ground structures, however.

Existing Wildlife Usage and Values

The site has moderate-to-high existing wildlife usage and values. A large variety of waterbirds, including dabbling ducks, herons, egrets, cormorants, and grebes, utilize the lake and associated permanent wetland channels. The abundant tree snags in the lake and vicinity are utilized by woodpeckers, flickers, and nesting wood ducks.

Small mammals either recently observed by Service biologists or expected to occur on the area include opossum, hare, gray squirrel, ground squirrel, vole, muskrat, deer mouse, ringtail, weasel, mink, and skunks. Mid-to-large size resident or transitory mammals likely include beaver, coyote, fox, raccoon, river otter, and mule deer. Amphibians likely include both toads and frogs. Reptiles likely include the pond turtle, various lizards and skinks, and several snakes.

A moderately diverse array of non-waterbirds also utilizes the site. Many species are permanent residents while others are seasonal visitors. Included are numerous passerine species as well as several raptor (hawk and owl) species. Raptors recently observed include white-tailed kite, Cooper's hawk, sharp-shined hawk, northern harrier, rough-legged hawk, red-tailed hawk, and red-shouldered hawk. Raptor foraging values on the site are high, while reproductive values are much lower than at the Woodlake site, due in part to much less mature riparian forest cover.

The 66.0 acres of riparian forest/scrub-shrub floodplain along the southwestern border of the site has moderately high values to fisheries whenever it becomes flooded. This is also the only potion of the site where significant ecosystem processes and functions (related to the seasonal flooding) are still occurring. However, flooding occurs in only about 50% of years, and several low points and depressions in the floodplain may be significant sources of fish stranding as waters recede.

The SRA cover of the site is likely utilized by: juvenile salmonids for both rearing and migrations; adult Sacramento splittail, for pre-spawn foraging and spawning; juvenile splittail for foraging and grow-out, prior to moving back into the main river channel. In addition, this particular reach of SRA cover is seasonally (primarily spring-summer) used as cover for striped bass, a popular gamefish.

The large treed savannah area on the site, has high values to the VELB, due to the large number of elderberries it contains.

Our best professional judgement is that, overall, and assessed qualitatively on a scale of 1 (lowest) to 5 (highest-value), the Bushy Lake site would currently rate a 4. In comparison, (using the same scale), the Woodlake and Urrutia sites were judged a 5 and 2, respectively. These subjective estimates suggest that the Bushy Lake site may have less restoration potential (in terms of potential habitat-value gain per unit area) than the Urrutia site, but more than the Woodlake site. One function of the HEP application for the various restoration sites is to more objectively evaluate this issue.

Alternatives Evaluated

Just as for the other sites, JSA developed two concept design restoration alternatives for this site. Acreages, by cover-type and polygon, that would be created with the various restoration measures used in the concept designs are listed in Table 9. The two concept alternatives for Bushy Lake are more alike than the two alternatives at either the Woodlake or Urrutia site.

Key features of Alternative 1 would be restoration of mainly wooded savannah area to riparian forest (33.2 acres), oak savannah (89.2 acres), and oak woodland (2.8 acres). Also, a narrow (150-300-ft-wide) channel which extends upstream from near Business Highway 80 for about 1,500 ft (0.9 acre) into the 66.0-acre seasonal floodplain zone along the river would be improved by grading and channeling to create better flow-through hydrology. This would reduce or eliminate fish stranding potential and provide a small permanently flooded backwater area upstream of the highway. In addition, a 0.4-acre area in the northwestern corner of the Bushy Lake site known as Sump Pump No.152, would be converted from existing riparian forest/scrub-shrub/permanent wetland to emergent marsh area, mainly to improve (utilizing wetlands "filtration" benefits) water quality in the vicinity of the pump and in nearby Bushy Lake.

Alternative 2 would be similar to Alternative 1, involving creation of riparian forest (20.2 acres), oak savannah (80.4 acres), and oak woodland (2.6 acres)–all mostly from the existing savannah area. Neither the 0.9-acre seasonal floodplain improvement nor the 0.4-acre conversion to emergent marsh at Pump No.152 would occur. However, 30.8 acres of grassland area would be established in the existing savannah area–a feature that Alternative 1 would lack.

In addition, within both alternatives, there would be the same major restoration actions (measures 13 and 15) implemented along the site's existing SRA cover. The upstream 1,000 ft of this SRA cover would be completely removed, and the steep, eroding bank would be graded gradually back towards the Chicken and Strong Ranch sloughs channel entrance. This would create 4.2 acres of new floodplain area and establish the appropriate hydrology for creation of (in ascending elevation zones) shallow aquatic, seasonal wetland, and riparian forest. The same kind of habitat conversion would occur to the downstream 1,500 ft of SRA cover along the site; however, this would involve grading back about a relatively narrow 150-200-ft-wide swath along the bank and establishing the three new cover-types (on the ascending elevation zones).

Measures

The two concept design restoration alternatives would make use of 9 of the 25 total restoration measures, as follows:

- *Measure 6*–Plant riparian forest species;
- *Measure 7*–Grade the floodplain and create appropriate hydrology to support riparian forest species, and plant riparian forest species;
- *Measure 8*–Plant riparian oak woodland species;

- *Measure 9*–Plant oak savannah species;
- *Measure 10*–Seed and establish grassland;
- *Measure 13*–Modify hydrology and construct side-channels off the main river and plant shallow aquatic, seasonal wetland, and riparian forest species;
- *Measure 15*–Terrace steep, degraded river banks and plant with riparian forest species (except in this instance, a portion of the terraced area would actually be converted to shallow aquatic (20%) and seasonal wetland (20%) habitat)
- *Measure 16*–Restore connectivity between the river corridor and the floodplain terrace by lowering berms and establishing uniform elevations.
- *Measure 18*–Remove existing vegetation, grade, and establish an emergent wetland at the site of Sump Pump No. 152.

The relationships of the measures to concept alternatives and to specific cover-types and mapped polygons are shown in Table 9. (Also refer to JSA's Plates.)

Table 9. Measures, cover-types, and polygons evaluated using HEP for two preliminary conceptual alternatives at the Bushy Lake site, LAR.

ALT	MEASURE(S)	COVER-TYPE(S) AND POLYGON(S)			ACRES	TOTAL ACRES
1	7	Riparian Forest	-RFO1		9.46	
	7		-RFO2		20.33	
	6		-RFO3		1.99	
	6		-RFO4		1.37	33.15
	15	Riparian Forest	-RFO(X)	(60%)	4.02	
		+Seasonal Wetland	-NA	(20%)	1.34	
		+Shallow Aquatic	-NA	(20%)	1.34	6.70
	13	Riparian Forest	-RIP6		3.06	
		Seasonal Wetland	-SW1		0.79	
		Shallow Aquatic	-SAQ2		0.36	4.21
	1,8	Oak Woodland	-OW1		2.75	2.75
	9	Oak Savannah	-OS1		89.20	89.20

	16	Shallow Aquatic -SAQ1	0.93	0.93
	18	Emergent Wetland -EW1	0.39	0.39
ALTERNATIVE 1 TOTAL				137.33
2	7	Riparian Forest -RFO1	20.17	20.17
	15	Riparian Forest -RFO(X) (60%) +Seasonal Wetland -NA (20%) +Shallow Aquatic -NA (20%)	4.02 1.34 1.34	6.70
	13	Riparian Forest -RFO3 Seasonal Wetland -SW1 Shallow Aquatic -SAQ1	3.06 0.79 0.36	4.21
	1,8	Oak Woodland -OW1	2.57	2.57
	9	Oak Savannah -OS1 -OS2	33.53 46.87	80.40
	10+1,2, or 3	Grassland -GR1	30.76	30.76
ALTERNATIVE 2 TOTAL				144.81

Goals Governing the HEP Application

Just as for the other sites, an overriding goal shared by the Service and other agencies party to this evaluation is the restoration of significant ecosystem function, structure, and dynamic processes that have been degraded along the LAR system. Achieving this goal may entail restoring diverse native plant communities and habitats, improving connectivity and functionality between habitats, re-creating hydrologic interaction between the river and its floodplain areas, and reducing potential for fish stranding in unnatural or adversely modified floodplain areas. These potential actions were incorporated to the degree practicable for this particular site using the nine measures described above.

In addition, the Service adopted five site-specific goals, based on existing site-specific conditions at the Bushy Lake site, which governed how the HEP was designed, conducted and interpreted: (1) to preserve or improve overall fish and wildlife habitat values to the extent feasible; (2) to improve raptor values; (3) to ensure that the lineal losses, areal losses, and habitat-value losses resulting from any and all conversions of SRA cover are fully offset and improved for the future by establishing better ecosystem functioning than now; (4) to ensure minimal temporal and no net long-term losses of existing elderberry acreages or values; (5) to improve habitat values for adult and juvenile Sacramento splittail, and juvenile salmonids.

HEP Team

The HEP team composition and utilization by the Service for this HEP application followed that of the Woodlake site. Refer to that discussion for details.

HEP Overview

The first step was to identify and enumerate the various mapped polygons for each of the two concept design alternatives, by measure and cover-type (Table 9). This provided a foundation for the same type of analysis as done for the three other sites, and ensured that the Corps would have results in a form to facilitate incremental analyses and development of other alternatives, including a “best buy” alternative.

The cover-types to be created and/or impacted at the Bushy Lake site were the same as (or very similar to) the Urrutia site. Thus, all of the evaluation species and HSI models (and their related SIs) for Urrutia were applied in the Bushy Lake site analysis, with one exception. While open water of Bushy Lake is present, the OWM evaluation species was not needed, because none of Bushy Lake’s open water area was proposed for restoration or habitat changes.

Sampling and Variable Measurement Methods

For those evaluation species that were the same as used at the Woodlake site (i.e., vole, owl FV, owl CRV, and SFCM) baseline condition sampling at the Bushy Lake site followed the same general procedures. Bushy Lake field sampling was done during March-April 2001. The resulting baseline conditions for these four evaluation species are in Appendix B.

In addition, field sampling to determine SRA cover baseline conditions was done during March 2001. SRA cover measurements entailed 35 sample plots systematically located along the 2,500-ft-long bank, with the procedures for SI determinations given in the SRA cover model strictly followed. Baseline results for SRA cover appear in Appendix B.

Field sampling of the 0.9-acre seasonal floodplain strip that would be improved under concept design Alternative 1 followed the sampling approach used for the Woodlake stranding pits sites, except 30 systematically located sample plots were utilized (Appendix B).

Field sampling was not necessary for determining baselines of any emergent marsh (EMM) or open water (OWM) areas at the Bushy Lake site, since these two cover-types are proposed for creation at the site, but no occurrences of existing habitat are proposed to be impacted.

Mean Weighted HSIs

Mean weighted HSIs were in certain instances calculated and used in the HEP accounting, just as for the other sites. Acreage was always the weighting factor. However, far fewer mean HSIs were derived than for the Woodlake site, because it was determined that this approach was in fact more time-consuming and cumbersome than simply accounting separately in the HEP for all evaluation species across all cover-types, and then summing results as appropriate for particular measures (and cover-types) of interest.

Futures Projections and HSI Derivations

Just as for the other sites, numerous future variables had to be projected. The various concepts, assumptions and principles underlying the projections used to derive future SIs and HSIs are presented in Appendix C.

Target Years Used in the Analyses

Just as for the other sites, HEP accounting was based on a 50-year period of analysis.

HEP Output/Results

The HEP accounting results were generally derived, collated, and summarized the same as for the Woodlake and Urrutia restoration sites.

Relative Value Indices

The same RVIs (and justifications for such) were used as were used for the Urrutia site analyses: SFCM and SRA cover-1.0; owl CRV and EMM-0.4; owl FV-0.3; and California vole-0.2.

Results and Discussion

The preliminary HEP results, in the form of a worksheet from which the AAAHUs for evaluation species were derived from AAHUs across the various cover-types and polygons, are given in Appendix D. From these data, the AAAHUs values, net gains, and gains/acre were tabulated (Table 10).

Results indicate that overall, similar habitat-value gains would accrue both from the two preliminary alternatives at the Bushy Lake site (0.29 and 0.27 AAAHUs/acre) and the two preliminary alternatives at the Woodlake site (0.31 and 0.23/acre). However, both of these two restoration sites would accrue less than the Urrutia site, where both of the preliminary alternatives have projected gains of 0.52AAAHUs/acre.

The results for measures 15 and 13 in Table 10 warrant further discussion. These are the actions (identical under Alternatives 1 and 2) that would eliminate existing SRA cover along 2,500 feet of shoreline, slope the bank back for up to 200 feet (more in the proposed upstream "backwater" area), and establish transition zones (proceeding up-slope) of new shallow aquatic, seasonal wetland, and riparian forest habitat. Currently, the SRA cover at this location has a baseline HSI of 0.53 (Appendix B), which means that it is roughly one-half as good as the "best" SRA cover.

The measure 15 and 13 actions would be relatively robust in terms of the relative average gains of AAAHUs/acre–ranging from 0.50 to 0.77 for measure 13, and from 0.49 to 0.74 for measure 15. Also, there would be 4.21 acres of seasonal floodplain created under measure 13 and 6.70 acres created under measure 15, versus the 0.57-acre of SRA cover that would be destroyed. Linear feet (LF) of SRA cover lost would also be reasonably offset or substantially increased, depending on measure. In particular, under measure 15, the downstream 1,500 LF of SRA cover that presently functions under a relatively restricted flow range (because of the steep, eroding bank) would be replaced by 1,500 LF of gradually-sloped, vegetated floodplain that would function (i.e., with flooded vegetation) over a much broader range of flows. And under measure 13, the greatly increased sinuosity of the new shoreline (associated with the creation of the backwater area) at various flows would result in up to (depending on flow) 3,500 LF of shoreline with significant soil/water/vegetation interaction versus the 1,000 LF of impacted SRA cover.

Thus, the analysis supports a finding that Measures 13 and 15 would both be desirable actions for inclusion in the restoration of this particular site. Nevertheless, a limiting factor not accounted for in the HEP involves the large number of elderberry shrubs present which would have to be removed along the top of the 2,500 LF of bank. VELB conservation guidelines would thus be a constraint and would have to be carefully factored into any more detailed analyses and/or decision to implement this restoration feature.

Measure 16, involving improvement of the 1,500-ft-long floodplain channel within the 66.0-acre seasonal floodplain area, would also have a relatively high habitat-value gain of 0.52 AAAHUs/acre (Table 10). Moreover, this figure was derived without perhaps fully valuing the considerable improvement to ecosystem functioning (from a more frequent and natural flooding regime) that would occur under this measure.Combined measures 1 and 8, involving creating oak woodland, and measure 9, involving creating oak savannah, would accrue gains of 0.23 and 0.26 AAAHUs/acre, respectively (Table 10). These figures are similar to values that would accrue for these measures at the Woodlake site, but higher than what would accrue for the oak woodland creation at the Urrutia site.

Creating grassland at the Bushy Lake site would accrue 0.15 AAAHUs/acre gain in value (Table 10). This is the same as at the Woodlake site, but higher than for the grassland proposed at the Urrutia site. (However, as discussed earlier, the low Urrutia value for grassland and oak woodland are anomalies due largely to poor present siting of the proposed polygons.)

Measure 18, which would create an emergent wetland “filter” in the vicinity of Sump Pump No.152, would result in a *loss* of 0.23 AAAHUs /acre. This is the only option examined using HEP from among the four restoration sites which would have a negative value. This loss would occur mainly because relatively high-value existing riparian forest, scrub-shrub, and permanent wetland habitat would have to be destroyed. There may be overriding arguments to help support the need for and benefits of a wetland filter at this particular location. However, to the Service’s knowledge, no evidence in support of the need for such a welands fiter has yet been presented.

Measure 7, in which riparian forest areas of either 29.8 (Alternative 1) or 20.2 acres (Alternative 2), would be created adjacent to Bushy Lake, would result in relatively low habitat-value gains of 0.29 AAAHUs/acre (Table 10). In comparison, various combinations of measure 7 options proposed at the Woodlake and Urrutia sites would each accrue from 0.38 to 1.19 of habitat-value gain in AAAHUs/acre. The relatively low benefits of the measure 7 at the Bushy Lake site are due mainly to the relatively high existing values of the savannah area that would be graded towards the lake and converted to riparian forest. In particular, the very large elderberries in this savannah area have some moderate owl CRV as well as relatively high owl FV and vole values

Table 10. Adjusted (by RVIs) habitat values from HEP for the Bushy Lake site, based on “measures” in the alternatives. (See site-specific discussion of RVIs and AAAHUs in text.)

MEAS. NO.	COVER-TYPE(S) PROPOSED TO BE CREATED	ACRES	TOTAL AAAHUS						
			No Action	Alt. 1	Net Gain	Gain/ Acre	Alt. 2	Net Gain	Gain/ Acre
7	Riparian Forest (RFO1)	9.46	3.48	6.19	2.71	0.29	-	-	-
		20.17	7.41	-	-	-	13.20	5.79	0.29
	Riparian Forest (RFO2)	20.33	7.47	13.31	5.84	0.29	-	-	-
6	Riparian Forest (RFO3)	1.99	0.63	1.30	0.67	0.34	-	-	-
	Riparian Forest (RFO4)	1.37	0.70	0.97	0.27	0.20	-	-	-
15	Riparian Forest (RFOX)	4.02	2.04	4.00	1.96	0.49	-	-	-
		4.02	2.04	-	-	-	4.00	1.96	0.49
	+ Seasonal Wetland (NA)	1.34	0.68	1.55	0.87	0.65	-	-	-
		1.34	0.68	-	-	-	1.55	0.87	0.65
	+ Shallow Aquatic - NA	1.34	0.71	1.70	0.99	0.74	-	-	-
		1.34	0.71	-	-	-	1.70	0.99	0.74
13	Riparian Forest (RIP6)	3.06	1.57	3.91	2.34	0.77	-	-	-
	Riparian Forest (RFO3)	3.06	1.57	-	-	-	3.91	2.34	0.77
	Seasonal Wetland (SW1)	0.79	0.44	0.91	0.47	0.60	-	-	-
		0.79	0.44	-	-	-	0.91	0.47	0.60

	Shallow Aquatic (SAQ2)	0.36	0.20	0.38	0.18	0.50	-	-	-
	Shallow Aquatic (SAQ1)	0.36	0.20	-	-	-	0.38	0.18	0.50
1,8	Oak Woodland (OW1)	2.75	1.10	1.74	0.64	0.23	-	-	-
		2.57	1.03	-	-	-	1.63	0.60	0.23
9	Oak Savannah (OS1)	89.20	32.82	55.95	23.13	0.26	-	-	-
	Oak Savannah (OS1)	33.53	12.31	-	-	-	21.04	8.73	0.26
	Oak Savannah (OS2)	46.87	17.21	-	-	-	29.40	12.19	0.26
16	Shallow Aquatic (SAQ1)	0.93	0.97	1.45	0.48	0.52	-	-	-
18	Emergent Wetland (EW1)	0.39	0.22	0.13	-0.09	-0.23	-	-	-
10	Grassland (GR1) +1, 2, or 3	30.76	11.30	-	-	-	15.96	4.66	0.15
ALTERNATIVE 1-TOTAL		137.33	53.03	93.49	40.46	0.29	-	-	-
ALTERNATIVE 2-TOTAL		144.81	54.90	-	-	-	93.68	38.78	0.27

(Appendix B). This elevated baseline reduces the gain that can be achieved. Moreover, the HEP does not consider the elderberry conservation plantings that would be required elsewhere on the site if the measure 7 scenario(s) were to be implemented.

Measure 6 involving the riparian forest RFO4 polygon would also be a relatively low-gain (0.20 AAAHUs/acre) restoration feature. This is because the site has relatively high baseline values which would be difficult to increase. However, cost must be considered for this polygon too, since it may require relatively little planting (and associated plant maintenance) to achieve the 0.20/acre figure.

The other measure 6 polygon–RFO3–would have a habitat-value gain rate of 0.34 AAAHUs/acre. The improved gain is because this polygon has lower existing values and lacks elderberries.

Third Bushy Lake Alternative–A Brief, Preliminary Analysis

Introduction and Background. The Corps and SAFCA provided the Service with a third design concept alternative (Alternative 3) for analysis just prior to the Corps' deadline for receipt of the Service's draft Fish and Wildlife Coordination Act Report. Because of the short time frame, we completed only a preliminary HEP analysis as described below. However, this was generally done in a manner to be consistent with the other HEP analyses of alternatives for the Bushy Lake site as well as the alternatives for the other sites. Thus, the results should facilitate application of the Corps' incremental cost analysis and development of a best buy alternative for the Bushy Lake site.

Alternative 3 was designed by JSA (*see* JSA Plate X) to ameliorate two significant aquatic-related environmental problems presently associated with the Bushy Lake site. The first problem is that Chicken Ranch and Strong Ranch sloughs, which enter the LAR from across the easterly edge of the site, are known to be contaminated with several heavy metals and pesticides. These contaminants, which are thought to cause serious aquatic organism toxicity problems for the LAR, are often in highest concentrations after "first flush" precipitation events (about the first ½ inch of runoff resulting from a periodic rainfall event). The second problem relates to Bushy Lake itself, which often has water quality problems caused by lack of water circulation. These problems include large and rapid PH fluctuations, relatively wide water temperature fluctuations, heavy nutrient loading, seasonally low dissolved oxygen, and other attributes of low water quality. In addition, to ameliorating water quality problems one site and in the LAR, Alternative 3 was also formulated by JSA as a means of reducing the current high costs of groundwater pumping to maintain Bushy Lake water levels during summer.

The central feature of Alternative 3 would be a long, circuitous drainage "swale" constructed to convey inflow from Chicken Ranch and Strong Ranch sloughs and Sump Pump No. 152 across the Bushy Lake site, including through Bushy Lake, and ultimately into the LAR at sites about midway downstream along the site.

During construction, Bushy Lake would be de-watered and reconstructed. About 20,000 cubic yards of material would be removed from the lake area to create distinct hydrology zones to support permanent open water (20%), seasonal wetlands (20%), and riparian forest (60%). The removed material would be appropriately redistributed on site to create topography changes to enhance other nearby habitat. A pump would be installed to lift water from the incoming sloughs into a pipeline. This pipeline would convey inflows a few hundred feet to a diversion weir at the easterly edge of the drainage swale complex. The outflow of the drainage swale complex would have a drop structure constructed. After exiting the drop structure, flows would follow natural existing drainage pathways along the southern floodplain border of the site. The flows would enter the LAR at multiple locations along this floodplain.

The greatly increased distribution and retention time of the incoming slough water across the site would be intended to provide significant wetland "filtration" benefits. The site has been determined to have high potential for filtration due to its relatively high capacity to absorb or percolate water. This percolation, and the attendant emergent plant growth that would occur in the swales, would presumably assist in "cleansing" pollutants biologically from slough inflows that would otherwise be dumped directly into the LAR.

However, operations would still have to be designed to prevent overwhelming the biological system and possibly creating new contaminant-related problems for fish and wildlife. One operational measure would be to limit distribution of first-flush flow events to the southernmost swales nearest the LAR. After first-flush inflows had been exceeded (i.e., after the first ½ inch of runoff from any given storm), storm inflows could then be distributed over all of the wetland complex, including Bushy Lake.

The proposed system would provide both abiotic and biotic treatment of contaminants through direct metabolism, photolysis, and sequestering of plant and detrital matter. The improved flow-through characteristics over the site would also reduce stagnation, thereby improving water quality parameters. In these ways, Alternative 3 would restore lost physical and biological processes on the Bushy Lake site. There would also be restorations of other key cover-types much the same as under Alternative 2 (*see* cover-type acreages below).

Restoration Measures. JSA developed two additional restoration measures relative to Alternative 3. Measure 18 is to "create a system of natural stream channels from Chicken Ranch and Strong Ranch sloughs across the Bushy Lake site and including multiple outlets to the LAR, and plant these features with appropriate wetland and riparian vegetation." Measure 25 is to "install a pump and piping system to convey Chicken Ranch and Strong Ranch sloughs inflows from the existing concrete-lined channel on the easterly edge of the site to the new natural stream channel system of the site to be created under Measure 18."

*Cover-Type Acreages***.** A 6.70-acre riparian forest (60%)/seasonal wetland (20%)/shallow aquatic (20%) area adjacent to the river along the southeastern edge of the site would be created exactly as under Alternative 1. Also, 86.04 acres of oak woodland savannah and 1.20 acres of riparian oak woodland would be created nearly identical (in polygon shape and placement) to the polygons for these two cover-types under Alternative 1. Alternative 3's primary divergence from the other two alternatives is that it would also create (a) 8.27 acres of swale stream channels, and (b) 27.68 acres of riparian forest, 9.23 acres of seasonal wetlands and 9.23 acres of permanent open water area during the excavation and grading of Bushy Lake. Therefore, the total new, restored or enhanced habitat acreage under Alternative 3 would be 148.35 acres compared to either 137.33 or 144.81 acres under Alternatives 1 and 2, respectively.

Derivation of AAAHUs. The late (in the planning process) delivery of this alternative from the Corps and SAFCA to the Service allowed insufficient time for the same relatively rigorous procedures as were used to derive the AAAHUs for the other two alternatives at this site to be followed. Instead, estimates of the gains of AAAHUs/acre that would be expected under the various Alternative 3 measure/cover-type combinations were derived using the other HEP results–specifically from either the other two Bushy Lake alternatives or other three terrestrial restoration site alternatives, as appropriate. In deriving these estimates, we also considered (a) the relative existing habitat values of the cover-types proposed for modification, and (b) the degree of impact the involved action measure(s) would have on existing habitat values. Rationale and assumptions for the Alternative 3 estimates of gains of AAAHUs/acre were as follows:

1. Measure 15: Riparian Forest/Seasonal Wetland/Shallow Aquatic on 6.70 acres–Identical to results (Table 10) for the same 6.70-acre area under either Alternative 1 or 2 at Bushy Lake.

2. Measure 9: Oak Woodland Savannah on 86.04 acres–Same rate of habitat value gain as for measure 9/OS1 results (Table 10) for Alternative 1. The other AAAHUs values can be appropriately prorated from these Alternative 1 values.

3. Measures 1,8: Riparian Oak Woodland on 1.20 acres–Same rate of habitat value gain as for measure 1,8/OW1 results (Table 10) for Alternative 1. The other AAAHUs values can be appropriately prorated from these Alternative 1 values.

4. Measures 18,25: Natural Swale Channel CH1 on 8.27 acres which is largely existing low-value herbaceous vegetation where, in excavating the swale, existing elderberry plants would be largely avoided to the extent feasible. Over time, the wetland vegetation planted within the swales would gradually become interspersed with woody riparian vegetation, thereby further increasing habitat values. Therefore, habitat value gain of this option would be relatively higher than that of emergent wetland EW1 under Alternative 1 at the Urrutia site (Table 8). A reasonable assumed rate of gain is 0.35 AAAHUs/acre.

5. Measure 7: Riparian Forest RFO1 on 27.68 acres–Same rate of habitat value gain (0.28 AAAHUs/acre) as for RFO1-4 for Alternatives 1 and 2 (Table 10) averaged together. Seasonal Wetland on 9.23 acres–Same rate of habitat value gain (0.05 AAAHUs/acre) as for SW1 and SW2 Seasonal Wetlands under Alternatives 2 and 1, respectively, at the Woodlake site (Table 5) averaged together. Open Water on 9.23 acres–an assumed rate of gain of 0.25 AAAHUs to account for the greatly improved water quality benefitting fish and wildlife.

Results and Discussion. The habitat-value results derived following the above rationale and assumptions are given in Table 10a. The individual measure/cover-type combinations would accrue from a low of 0.05 to a high of 0.74 AAAHUs/acre. The value for Alternative 3 as a whole was 0.27 versus 0.29 and 0.27 AAAHUs, respectively, for Alternatives 1 and 2. Thus, the three alternatives at the Bushy Lake site would not be appreciably different in terms of their projected habitat-value gains per acre of restoration effort.

Nonetheless, there are projected fish and wildlife benefits of Alternative 3 not factored into the HEP accounting which, if they prove to be accurate, would make it the superior choice among the three alternatives. First, the water quality of Bushy Lake would potentially be substantially improved. This would benefit a wide range of fish and wildlife which use the lake and the Bushy Lake site in general. Also, if the wetland filtration scheme functioned as projected, aquatic organism toxicity within the LAR downstream of the discharge point of the sloughs would potentially be lessened. In addition, habitat values of the site as a whole would benefit from the increased diversity and complexity of cover-types, compared to either Alternative 1 or 2.

On the other hand, the worthy goal of lessening contaminant-related aquatic organism toxicity problems in the LAR which Alternative 3 seeks to attain would create the highest risk among the three Bushy Lake alternatives. The levels of diazinon recorded in Chicken Ranch and Strong Ranch sloughs are currently the highest ever recorded anywhere in the State. At the present time, this pesticide, other pesticides, and several heavy metals are discharged into the river from the sloughs. While this likely at times has significant direct, indirect, and cumulative adverse effects on the LAR's fish and wildlife, there may nevertheless be significant buffering effects occurring through dilution, as the sloughs enter the LAR, as the LAR enters the Sacramento River and as the Sacramento River enters the Delta.

A contaminant specialist of the Service who has reviewed the preliminary design concept of Alternative 3 has concluded that it would be difficult, if not impossible, to predict beforehand

Table 10a. Adjusted (by RVI's) habitat values from HEP for Bushy Lake Alternative 3, based on "measures" in the alternatives. (AAAHUs gain/acre for the site as a whole was a weighted [by acres] mean of the component values.)

MEAS. NO.	COVER-TYPES TO BE CREATED	ACRES	TOTAL AAAHUs			
			No Act.	Alt. 3	Net Gain	Gain/A.
15	Riparian Forest	4.02	2.04	4.00	1.96	0.49
	+ Seasonal Wetland	1.34	0.68	1.55	0.87	0.65
	+ Shallow Aquatic	1.34	0.71	1.70	0.99	0.74
9	Oak Woodland Savannah	86.04	31.66	53.97	22.31	0.26
1, 8	Riparian Oak Woodland	1.20	0.48	0.76	0.28	0.23
18, 25	Natural "Swale" Channel	8.27	-	-	-	0.35
7	Riparian Forest	27.68	-	-	-	0.28
	Seasonal Wetland	9.23	-	-	-	0.05
	Open Water	9.23	-	-	-	0.25
ALTERNATIVE 3 TOTAL/AVERAGE		148.35	-	-	-	0.27

whether this alternative would indeed achieve its projected beneficial results in terms of wetland contaminant filtration. It is possible that a serious new contaminant-related fish and wildlife problem could be created on the Bushy Lake site. The greatest threats are likely related to mercury and diazinon. Bioaccumulating concentrations of these pollutants are known to cause direct and indirect fish and wildlife mortality and abnormalities. Diazinon accumulations in particular can result in acute toxicity problems for lower food-chain invertebrates.

Due to its risks and to ensure that a new contaminant problem is not created for fish and wildlife under Alternative 3, staged implementation would be essential. After each stage was completed, appropriate contaminant monitoring of fish and wildlife and their habitats would need to be conducted. Sequential stages could then be completed if not problems were detected.

Conclusions. Despite similar HEP values among the three alternatives at Bushy Lakes, Alternative 3 has the greatest potential for fish and wildlife habitat-value improvements. The Service would likely endorse implementation of Alternative 3 provided that: (a) impacts to elderberries and VELB were fully avoided, minimized and offset using Service conservation guidelines for the VELB; (b) all wetland filtration aspects of the project were implemented incrementally in stages which could, if necessary, be halted; and (c) each constructed stage would be monitored and evaluated to ensure than a serious new contaminant-related problem for fish and wildlife is not created requiring the project to be halted.

Overall Conclusions for the Bushy Lake Site

The Service would likely *provisionally* endorse implementation of most of either concept Alternative 1, 2 or 3 as they are presently described, or any other materially and significantly similar alternative as the Corps may develop by combining the measures and polygons (or similar polygons) evaluated herein. Our provision is that all impacts to the site's existing elderberry shrubs and trees would have to be fully avoided, minimized and appropriately offset according to Service conservation guidelines for the VELB. Determining the degree to which this can actually be done for the various cover-types under different alternatives will necessitate more detail plans and detailed surveys of the elderberries which occur within the "footprints" of the restoration features.

Of the three preliminary concept design alternatives, Alternative 3 is tentatively preferred by the Service. However, Alternative 3 implementation must be contingent upon the staged development and pollutant monitoring and evaluation as described above.

Alternative 3 at the Bushy Lake site could potentially be of equal or greater fish and wildlife value as either of the two preliminary alternatives at the Urrutia site or Alternative 1 for the Woodlake site. Alternatives 1 and 2 at Bushy Lake would generally be inferior to these same other three alternatives.

Losses of SRA cover along 2,500 LF of bank such as would occur under current measures 13 and 15 in the three alternatives would likely be acceptable to the Service provided that the associated losses of elderberries could be fully avoided, minimized and conserved following Service conservation guidelines for the VELB.

Establishment of a grassland parcel on the site of not less than the 30.8 acres proposed under Alternative 2 would be a desirable feature of any selected alternative so as to reduce hazards of wildland fires destroying habitat and to improve feeding conditions for raptors which utilize the site.

Measure 16 under Alternative 1, involving improving the 1,500-ft-long seasonal floodplain channel, would be a desirable feature of any selected alternative for the site, because of its restoration of floodplain functioning.

Inclusion of measure 7, which entails grading and removal of existing vegetation before riparian forest is reestablished, would have marginal habitat-value benefits in any alternative recommended for implementation. Again, such a measure would likely be acceptable only if associated losses of elderberries could be fully avoided, minimized and conserved following Service conservation guidelines for the VELB.

IV. ARDEN BAR SITE

Location and General Description

The Arden Bar site (*see* JSA Plate 8) is located within the American River Parkway on the inside (right bank) of a large meander (floodplain) bend in the vicinity of RM 13. The site is just upstream (and on the opposite side of the river) from the Grist Mill access into the parkway, and just downstream (and opposite) from Goethe Park. The site comprises 123.6 acres. It is thus by far the smallest of the four sites being evaluated for restoration. Also, this site has a much more irregular surface and more exposed cobble and gravel (remnants of hydraulic mining) than the other three sites. In addition, the site is in the free-flowing zone of the river, whereas the other three sites are within the river's backwater zone. (For additional discussion of these zones, refer to the SFCM in Appendix A).

Cover-Type Delineations and Mapping

Mapping of the baseline conditions and two concept design alternatives, and determinations of habitat acreages, were completed by JSA just as for the three other sites.

Existing Cover-Types and Conditions

Of the site's 123.6 acres, the central 33.8 acres is an open water pond (Arden Pond) which provides recreational fishing from the banks and via a well-maintained fishing pier. The California Department of Fish and Game's Fishing in the City Program plants rainbow trout in the pond during winter and channel catfish during summer. Because the pond is part of the seasonal floodplain across the meander bend, it is occasionally overtopped by the river during high releases from Folsom and Nimbus dams. Two small islands totaling 0.7 acre occur near the center of the pond.

Two contiguous prominent features occurring along the western edge of the site are a 33.4-acre Sacramento County Sheriff's Department Training Facility and a 45.4-acre park, with typically manicured lawn and paved parking lots. The training facility, which is surrounded by earthen levees, was formerly a sewage treatment facility. Much of the original infrastructure, including several large metal tanks, from the sewage treatment operation remains on this parcel. Neither the training facility nor the park currently provide any significant fish and wildlife usage or values. Improvement of fish and wildlife values on the training facility is a component of both concept design alternatives. However, the park would in no way be involved in the restoration efforts.

Other significant existing habitat elements of the site, all of which occur contiguous to or in the vicinity of Arden Pond, include: ruderal/upland area–48.4 acres; several patches of riparian forest/scrub-shrub–33.1 acres; barren cobble and/or gravel area–3.7 acres; a patch of oak grassland/upland with yellow starthistle–1.1 acres; a small shallow aquatic area along the southerly bank–0.4 acre; two small seasonal wetlands–0.7 acre; and a patch of non-native, invasive shrubs–1.7 acres.

Another important feature of the site not included in acreage totals is the 60.4 acres of braided river channel with numerous vegetated islands occurring along the eastern edge of the site and right bank of the river.

Existing Fish and Wildlife Usage and Values

Overall, existing fish and wildlife usage and values of the site range from low to moderate. The pond is seasonally used for feeding and resting by moderate numbers and diversity of water bird species, particularly Canada geese, various "dabbling" ducks, coots, grebes, herons, egrets, and cormorants. Nesting by geese and dabbling ducks, especially mallards, also occurs on the two small islands. The pond also supports frogs and turtles.

The forested patches of the site have good diversity, multiple canopy layers, and quite often relatively dense vegetative structure, all of which equate with high fish and wildlife values. However, these patches are relatively small and often interspersed or heavily dominated by invasive, exotic plants, such as scarlet wisteria. The exotics and small patch size significantly reduce habitat values. Nevertheless, the 16.5-acre patch of cottonwood/willow scrub in the southeastern portion of the site currently supports at least one nesting pair of Swainson's hawks, and possibly other raptor species. Several raptors of three species were recorded by Service biologists during recent site visits. In addition, this area of the site is reported to support a heron nesting and/or roosting population. The forest and scrub habitat of the site also supports dozens of the many passerine birds which occur in the Parkway.

Except for foraging by raptors, the ruderal/upland habitat of the site is relatively low in wildlife usage and value. This is mainly because of the abundance of bare ground and cobble, and the low diversity and density of herbaceous ground cover.

Most of the site becomes a floodplain during high flows. At such times, the flooded habitat likely becomes highly important in the support of juvenile salmonids. However, because of the uneven surface with many pits, depressions, and other low points, there may be significant stranding of salmonids and other fish when flood waters recede. Also, significant predation on juvenile salmonids by Sacramento pikeminnows and various sunfish (Centrarchidae family) is a potential problem within Arden Pond, whenever flows overtop the pond borders. Neither the potential stranding problem nor predation problem has been studied or documented at this site, however.

Like the Bushy Lake site, this site has a very large number of elderberry shrubs which may support VELBs. Elderberries are particularly abundant in the 16.5-acre forest/scrub patch which supports the nesting Swainson's hawks.

The adjacent 60.4-acre braided channel/island area is highly important rearing habitat for juvenile salmonids, including both salmon and steelhead. Also, in some years, salmon are known to use this area for spawning.

The various birds, mammals, reptiles, and amphibians described above for the Woodlake and Bushy Lake sites, and common throughout the Parkway, would be expected to be either residents or transients on the Arden Bar site. However, much smaller numbers of these species would be expected, due the this site's small size and limited areal extent of vegetative cover patches.

Alternatives Evaluated

Just as for the three other sites, JSA developed two concept design alternatives for the restoration of this site. Both alternatives assume that the levee around the training facility parcel would be removed (either as part of the restoration, or by other entities) allowing for about 10-11 acres to be restored to fish and wildlife habitat, and leaving about 22-23 acres which could be added to the adjacent park (by the County or other entities). Acreages of the two preliminary alternatives, by cover-type and restoration measure, are given in Table 11.

Alternative 1 would modify 68.4 acres of the site (Table 11). The centerpiece feature would be a 6.9-acre high-flow channel running roughly from northeast to southwest across the site and through the southern half of Arden Pond. This channel would essentially be a cobble-lined, auxiliary river bed connecting two points on the river and designed to function at high flows. An inflow control structure at the upstream entry point would regulate and stabilize such flows. Dense vegetation would need to be avoided within the channel itself, but the banks of the channel would be lined with 4.5 acres of willow scrub (necessitating additional filling of the pond). The other elements of the alternative would be: six patches of riparian forest totaling 26.6 acres; three patches of oak woodland savannah totaling 28.8 acres; 0.5 acre of shallow aquatic habitat; and 1.2 acres of emergent wetland in six small patches around the periphery of Arden Pond. About 10 acres of the southeast corner of the training facility would be involved in the above conversions to oak woodland/savannah and riparian forest. Overall, Alternative 1 would reduce the size of Arden Pond from 33.8 to about 17.8 acres of open water.

Table 11. Measures, cover-types, and polygons evaluated using HEP for two alternatives at the Arden Bar site, LAR.

ALT	MEASURE(S)	COVER-TYPE(S) AND POLYGON(S)	ACRES	TOTAL ACRES
1	22	Willow Scrub -WS1	2.69	
		-WS2	0.24	
		-WS3	1.52	4.45
	7,24	Riparian Forest -RFO1	15.89	
	7	-RFO2	1.12	
		-RFO3	0.99	
		-RFO4	1.01	
		-RFO5	5.49	
		-RFO6	2.06	26.56
	23	Shallow Aquatic -SAQ1	0.51	0.51
	17	Emergent Wetland -EW1-6	1.17	1.17
	7,9	Oak Woodland/Savannah -OWS1	21.27	
	9,24	-OWS2	6.41	
	9	-OWS3	1.13	28.81
	14	High-Flow Channel -HFC1	6.92	6.92
		ALTERNATIVE 1 TOTAL		68.42
2	7,24	Riparian Forest -RFO1	22.57	22.57
	7	Riparian Forest/Reshape Bank-RB1	4.33	
		-RB2	3.42	7.75
	17	Emergent Wetland -EW1-6	0.96	0.96

	9,24 9 9	Oak Woodland/Savannah -OWS1 -OWS2 -OWS3	6.41 13.13 1.13	20.67
	21	Oak Woodland -RLOW1	3.33	3.33
ALTERNATIVE 2 TOTAL				55.28

Alternative 2 would forego the high-flow channel and its associated willow scrub-lined banks. However, riparian forest would still be created in three patches totaling 30.3 acres, 7.8 acres of which would occur atop fill placed into Arden Pond in two parcels. Oak woodland/savannah would be created in three patches totaling 20.7 acres. And six small patches of emergent wetland would still be created around Arden Pond totaling 1.0 acre. In addition, a 3.3-acre patch of oak woodland would be created atop a new raised levee area along the north side of Arden Pond where high river flows currently overtop and enter the pond. Overall the action would result in about 11 acres of the southeast corner of the training facility being reclaimed as habitat, just as in Alternative 1. Alternative 2 would thus reduce the open water of the pond to 26.7 acres.

All of the proposed new riparian forest patches under both alternatives would necessitate first grading the sites to create appropriate hydrology. That would mean that in some instances significant amounts of riparian forest and/or scrub-shrub would have to be removed. The amount of such removal was an important consideration in the HEP assumptions (Appendix C) and accounting.

Measures

The two concept design alternatives would involve use of 8 of the 25 total JSA restoration measures, as follows:

- *Measure 7*–Grade the floodplain and create appropriate hydrology to support riparian forest species, and plant riparian forest species;
- *Measure 9*–Plant oak savannah species;
- *Measure 14*–Excavate (and fill, as necessary) so as to create a high-flow bypass channel connecting portions of the main river, stabilize the bed with cobble rock, and install an inflow control structure;
- *Measure 17*–Construct low-elevation bank benches in interior open waters and plant with emergent wetland species;
- *Measure 21*–Fill and plant with native riparian oak woodland species;

- *Measure 22*–Plant willow species along the banks of the proposed high-flow bypass channel;

- *Measure 23*–Create shallow aquatic habitat at the outlet of the proposed high-flow bypass channel to create permanent lentic habitat for native fishes; and

- *Measure 24*–Remove the berm around the Sheriff's Training Facility (former sewage treatment facility).

Table 11 shows the relationships of the measures to alternatives, cover-types, and specific polygons mapped by JSA.

Goals Governing the HEP Application

Just as for the three other sites, an overriding goal shared by the Service and various agencies party to this evaluation is the restoration of significant ecosystem function, structure, and dynamic processes that have been degraded along the LAR system. Achieving this goal may entail restoring diverse native plant communities and habitats, improving connectivity and functionality between habitats, re-creating hydrologic interaction between the river and its floodplain areas, and reducing potential for fish stranding in unnatural or adversely modified floodplain areas. These potential actions were incorporated to the degree practicable for this particular site using the eight measures described above.

In addition, the Service adopted three site-specific goals, based on existing site-specific conditions at the Arden Bar site, which governed how the HEP was designed, conducted and interpreted: (1) to preserve or improve overall fish and wildlife habitat values to the extent feasible; (2) to ensure no temporal or net long-term losses of either existing elderberry (and VELB) acreages or values; (3) to ensure that any heron rookery on the site is not impacted; and (4) to improve habitat values for rearing juvenile salmonids.

HEP Team

The HEP team composition and utilization by the Service for this HEP application followed that of the Woodlake site. Refer to that discussion for a discussion.

HEP Overview

The first step was to identify and enumerate the various mapped polygons for the baseline conditions and each of the two concept design alternatives by measure and cover-type (Table 11). This provided a foundation for the same type of analysis as completed for the other sites, and ensured that the Corps would have results in a form to facilitate incremental analyses and development of other alternatives, including a "best buy" alternative.

The cover-types that are either present now or would be created at the Arden Bar site are much the same as for the Urrutia site. Therefore, the same evaluation species, HSI models and related SIs as used at Urrutia were also used for the Arden Bar analysis. One exception is that the SRA cover evaluation species was not employed in the Arden Bar analysis. Instead, all values that would be associated with creation of the high-flow channel were tracked using the SFCM evaluation species.

Sampling and Variable Measurement Methods

Maps with the concept design alternatives for the Arden Bar site were not available to the Service until late in the analysis period. Therefore, to complete our analysis in time to meet Corps planning document deadlines necessitated a highly expeditious approach to the field baseline sampling. Thus, the following alternative sampling strategy was employed: First, a single observer conducted a detailed, half-day reconnaissance walk over the entire site. Mapped (by JSA) cover-types were examined and compared to actual conditions, with particular attention given to identifying habitat areas with either heterogeneity or homogeneity. Field observations were recorded directly onto the maps. Then, a total of 35 systematically-selected sampling stations were positioned over the entire site from which to measure or visually estimate, as appropriate, the various SIs for the evaluation species. Sampling stations were intentionally more numerous in the heterogenous than homogenous areas of existing habitat.

When multiple sampling stations occurred within a particular mapped polygon, a mean weighted (based on acreage) HSI was calculated for each evaluation species. If a mapped polygon or sub-polygon did not have any respective sampling stations, the nearest representative station data was selected and used. All of the observations were then collated and displayed in a spreadsheet. This spreadsheet has not been included herein, but is available upon request from the Corps Projects Branch at the Service's Sacramento Office.

Mean Weighted HSIs

During the HEP accounting mean weighted HSIs were calculated, with acreages as weighting factors, just as for the other sites. However, far fewer mean HSIs had were derived than for the Woodlake site, since it had been determined that this approach was in fact more time-consuming and cumbersome than simply accounting separately in the HEP for all evaluation species across all cover-types, and then summing results as appropriate for particular areas of interest.

Futures Projections and HSI Derivations

Just as for the other sites, numerous future variables had to be projected. The various concepts, assumptions and principles underlying the projections used to derive future SIs and HSIs for the Arden Bar site are presented in Appendix C.

Target Years Used in the Analyses

Just as for the other sites, all HEP accountings were based on a 50-year period of analysis.

HEP Output/Results

The HEP accounting results were generally derived, collated, and summarized the same as for the Woodlake and Urrutia sites.

Relative Value Indices

For the four evaluation species common to all four restoration sites, the same RVIs were used: SFCM-1.0; owl CRV-0.4; owl FV-0.3; and California vole-0.2. The RVI for EMM-0.4–was the same as used for the Urrutia and Bushy Lake sites; justification for this RVI is the same as given in above in the Woodlake discussion.

The OWM RVI was *increased* from 0.2 used for the Urrutia and Bushy Lake sites to 0.3 for the Arden Bar analyses. This was because the existing open water at Arden Bar has generally higher value than open water at Urrutia/Bushy Lake sites, due to: shallower depths; more gradually sloped, and more sinuous, shoreline; adjacent dense riparian vegetation; and islands which support waterbird reproduction.

Results and Discussion

Preliminary results, in the form of a worksheet from which the AAAHUs were derived from AAHUs across all cover-types and polygons, are presented in Appendix D. These data were then consolidated into the standard format using AAAHUs as shown below in Table 12.

Results (Table 12) show that the average habitat-value gain of Alternative 1 (0.35 AAAHUs/acre) would be slightly superior to Alternative 2 (0.31/acre). Thus, overall average gains at Arden Bar would be slightly greater than at either the Woodlake (0.31 [Alt.1] and 0.23/acre [Alt.2]) or Bushy Lake (0.29 [Alt.1] and 0.27/acre [Alt.2]), but well below the values that could be achieved at the Urrutia site (0.52/ace [Alts.1-2]).

Measure 14, the high-flow channel, would accrue 0.45 AAAHUs/acre (Table 12) despite the channel itself not being vegetated. The gain would be mostly in the form of increased habitat values to juvenile salmonids. The associated willow scrub to be established (measure 22) along the high-flow channel banks would accrue from 0.42 to 0.63 AAAHUs/acre, depending on the patch location. However, the shallow aquatic area (SAQ1-measure 23) to be sited at the mouth of the high-flow channel would accrue a value of 0.77 AAAHUs/acre. Thus, overall, the high-flow channel and its associated features would be a moderately beneficial restoration option. However, this considers only habitat values, without any cost data or analysis.

The various riparian forest patches (measure 7, and measures 7 and 24 combined) proposed at the site would accrue widely variable benefits, ranging from 0.27 for patch RFO1 to 0.70 AAAHUs/acre for patch RF03 (Table 12). These differences would be related mainly to the amount and quality of existing forest and scrub-shrub cover at the patch sites that would have to be removed in the grading and replanting processes. However, these particular results must be used with some caution, because the HEP accounting did not factor in benefits that would accrue from removing non-native vegetation and replacing it with native species. Thus, the riparian forest values should all be considered *minimum* habitat-value gain estimates.

The proposed actions creating new areas of oak forest on the site (measure 21; combined measures 7 and 9; and combined measures 9 and 24) would also produce variable benefits from a low of 0.08 for patch OWS3 to 0.55 AAAHUs/acre for OWS1 (Alt.2) and OWS2 (Alt.1) (Table 12). These differences are also related to on-site impacts related to patch existing conditions.

Measure 17, which would entail establishing patches of emergent marsh around the periphery of Arden Pond, would return only a relatively modest habitat-value gain of 0.32 (Alt.2) to 0.33 AAAHUs/acre (Alt.1). However, this might still be a viable option, depending on related costs. A number of the individual patches of habitat that would be created under several of the measures at Arden Bar could involve significant losses of VELB habitat in the form of the elderberry host plants. While this potential problem is not as great as at the Bushy Lake site, VELB avoidance and compensation, for unavoidable impacts, could nevertheless become important constraint at certain patch locations. Unlike the Bushy Lake site, there were no measure/cover-type combinations at Arden Bar that would create a negative gain of habitat value.

Conclusions: Preliminary Concept Design Alternatives

The Service would likely *provisionally* endorse implementation of either concept design Alternative 1 or 2, as presently described, or any other materially and significantly similar alternative as the Corps may develop by combining the measures and polygons (or similar polygons) evaluated herein. Our provision is that all impacts to the site's existing elderberry shrubs and trees would have to be fully minimized and appropriately offset according to Service conservation guidelines for the VELB. Determining the degree to which this can actually be done for the various cover-types will necessitate more detail plans for alternatives and more detailed surveys of the site's elderberries, especially those which occur within the "footprints" of various proposed restoration features.

Based only on consideration of habitat-value gain/acre, Alternative 1 would be only slightly preferable to Alternative 2. However, considering habitat-value gain, plus the question of which alternative would best fulfill various restoration and HEP goals, Alternative 1 would be substantially superior to Alternative 2. In particular, we believe that measure 14–the high-flow channel and associated features–has high desirability and should be an integral component of any alternative that is proposed for implementation.

Table 12. Adjusted (by RVIs) habitat values from HEP for the Arden Bar site, based on "measures" in the alternatives. (See site-specific RVI and AAAHUs discussions in text.)

MEAS NO.	COVER-TYPE(S) PROPOSED TO BE CREATED	ACRES	TOTAL AAAHUS						
			No Action	Alt. 1	Net Gain	Gain/ Acre	Alt. 2	Net Gain	Gain/ Acre
22	Willow Scrub (WS1)	2.69	0.58	2.27	1.69	0.63	-	-	-
	Willow Scrub (WS2)	0.24	0.11	0.21	0.10	0.42	-	-	-
	Willow Scrub (WS3)	1.52	0.35	1.28	0.93	0.62	-	-	-
7, 24	Riparian Forest (RFO1)	15.89	11.13	15.41	4.28	0.27	-	-	-
		22.57	15.82	-	-	-	21.89	6.07	0.27
7	Riparian Forest (RFO2)	1.12	0.26	0.98	0.72	0.64	-	-	-
	Riparian Forest (RFO3)	0.99	0.23	0.92	0.69	0.70	-	-	-
	Riparian Forest (RFO4)	1.01	0.55	0.97	0.42	0.42	-	-	-
	Riparian Forest (RFO5)	5.49	1.27	4.91	3.64	0.66	-	-	-
	Riparian Forest (RFO6)	2.06	0.80	1.82	1.02	0.50	-	-	-
	Riparian Forest (RB1)	4.33	1.00	-	-	-	3.47	2.47	0.57
	Riparian Forest (RB2)	3.42	0.79	-	-	-	2.74	1.95	0.57
17	Emergent Wetland (EW1-6)	1.17	0.29	0.68	0.39	0.33	-	-	-
		0.96	0.24	-	-	-	0.55	0.31	0.32
23	Shallow Aquatic (SAQ1)	0.51	0.23	0.62	0.39	0.77	-	-	-
14	High Flow Channel (HFC1)	6.92	1.95	5.04	3.09	0.45	-	-	-
21	Oak Woodland (RLOW1)	3.33	0.81	-	-	-	1.82	1.01	0.30
7,9	Oak Woodl/Savannah (OWS1)	21.27	11.91	15.17	3.26	0.15	-	-	-
9, 24	Oak Woodl/Savannah (OWS2)	6.41	0	3.51	3.51	0.55	-	-	
	Oak Woodl/Savannah (OWS1)	6.41	0	-	-	-	3.51	3.51	0.55
9	Oak Woodl/Savannah (OWS2)	13.13	7.38	-	-	-	9.25	1.87	0.14
	Oak Woodl/Savannah (OWS3)	1.13	0.80	0.89	0.09	0.08	-	-	-

	Oak Woodl/Savannah (OWS3)	1.13	0.80	-	-	-	0.89	0.09	0.08
ALTERNATIVE 1-TOTAL		68.42	30.46	54.68	24.22	0.35	-	-	-
ALTERNATIVE 2-TOTAL		55.28	26.84	-	-	-	44.12	17.28	0.31

Riparian forest and oak woodland/savannah creation options would have highly variable benefits, depending on where patches were sited. If due to funding constraints or other reasons, not all patches evaluated in the HEP can be included, they should be ranked and included on the basis of habitat-value gains/acre (most to least), and included in that order. This assumes costs being equal per unit area.

Emergent marsh patches (measure 17) around Arden Pond should be a restoration project feature to the extent costs and gains compare favorably with other measures at this site.

Overall, the benefits of the Arden Bar site would be slightly higher per unit area than either the Woodlake or Urrutia sites, but substantially lower than the Urrutia site.

Conclusions: Corps' Currently Recommended Plan

Subsequent to the Service's analysis presented above for the two concept design alternatives, the Corps and JSA used the Corps' planning principles and guidelines, and incremental cost analyses, to develop a "best buy" plan for the Arden Bar restoration site. This best buy plan is called the "recommended plan" in the accompanying Corps environmental document. JSA Plate X shows the designs and locations of the various restoration measure polygons for the Arden Bar site under the recommended plan.

The Service has determined that the recommended plan has no significant polygon design changes and only very minor acreage changes compared to concept design Alternative 1 for the site. Acreage differences of the various measures between the two plans generally vary by less than 10 %.

The recommended plan would thus generally achieve the goals established for both the restoration effort in general and for the HEP at this distinct restoration site. In particular, a relatively moderate amount of new riparian habitat structure and low-to-moderate amount of ecosystem process functioning would be established or re-created. Losses of existing SRA cover would not be an issue. Negative impacts to existing high-value habitat areas would be relatively small. It appears that the potential to disturb or displace the possible heron rookery in the southern portion of the site would be low. The potential for detrimental impacts to federally listed terrestrial species, including the VELB, would be relatively small. Improvements to habitat values for listed aquatic species, including juvenile Central Valley steelhead, and for juvenile fall-run chinook salmon, which are candidate for listing, would be low-to-moderate. In this manner, the restoration effort would be expected to contribute incrementally towards steelhead recovery and to preventing fall-run chinook from becoming listed.

One possible drawback of the recommended plan would be the uncertainty and somewhat experimental nature of constructing the high-flow bypass channel across the southern half of the site. It is uncertain whether under existing hydrology this channel could be kept open and functioning in its design state over an extended period of up to several decades. A monitoring and remedial-action plan would clearly be necessary for assuring this. In addition, similar biological monitoring and remediation would be desirable to ensure that juvenile salmonid use of the channel was having positive results.

The Service supports implementation of the recommended plan for the Arden Bar site, subject to the "Recommendations Relative to the Five Restoration Options" presented later within this report.

V. FOLSOM DAM TEMPERATURE CONTROL SHUTTER MODERNIZATION

Introduction and Background

At times, high water temperatures are a serious limiting factor affecting the reproduction, growth and survival of anadromous salmonids in the LAR. Historically, this is not thought to have been a problem. Before the modern era of dams and development on the American River, adult salmonids returning to the river to spawn were transiently and periodically exposed to warm water temperatures in the Sacramento-San Joaquin Delta, lower Sacramento River, and LAR. However, upon their ascent to over 100 miles of upstream historic spawning and rearing reaches above where Folsom Dam is now sited, perennially cooler water temperatures were encountered and water temperatures were likely rarely, if ever, an important population-limiting factor. Moreover, most downstream movements of juvenile salmonids are believed to have historically occurred during spring and early summer, when LAR flows were high and cool due to runoff from the melting snowpack in the nearby Sierra Nevada Mountains.

Under present conditions and with existing facilities, including Folsom and Nimbus dams, in-river salmonid habitat has been artificially compressed within, and restricted to, the LAR. The present LAR in-river salmonid habitat quality is highly influenced by the capacity of Folsom Reservoir facilities to manage the cool water resources and releases to the LAR. However, frequently the temporal availability and cool water pool volume available from Folsom Reservoir are major limitations to optimal temperature management for salmon and steelhead.

The two most common adverse biological impacts are: (1) exposure of pre-spawning adult salmon to elevated water temperatures in the fall; and (2) exposure of juvenile steelhead to

elevated water temperatures during the spring through early fall, particularly during hot summer periods of maximum solar radiation. Such impacts do at times, depending on the severity and duration of the elevated water temperatures, become population-limiting factors for LAR anadromous salmonids.
Maintenance of optimal water temperatures for salmonids in the LAR depends on the ability to deliver cool water releases to the river from Folsom Dam and hence through Nimbus Dam. This in turn is governed by: (1) the volume of cool water pools available behind the dams (mainly behind Folsom Dam); and (2) the ability to physically access this cool water and deliver it downstream as needed for fisheries purposes.

Water Temperature Objectives

Currently, LAR temperature management is coordinated through the LAR Operations Group, which has technical representatives from U. S. Bureau of Reclamation, National Marine Fisheries Service (NMFS), California Department of Fish and Game, Western Area Power Administration, the Service and local interests. The group follows an adaptive management framework. Using information on current status of cool water availability, forecasts of Folsom Reservoir operations, and the operational limitations of the existing Folsom Reservoir shutters, the group recommends LAR water temperature objectives for salmonids.

During adaptive management planning by the LAR Operations Group an iterative process referred to as the Automated Temperature Selection Procedure (ATSP) is followed. In ATSP, target water temperatures, as measured in the river flow at Watt Avenue, are achieved by drawing release water from specific reservoir levels. The most preferred (and realistically achievable) Schedule 1 water temperatures at Watt Avenue which would have the lowest impacts to salmonids are: 56^0F during May; 56.5^0F during June; 65^0F during July-September; 57^0F during October; and 55^0F during November. River water temperatures are not considered to be a problem during the remaining months (December-April) when river water temperatures are generally cool.

Under the ATSP process, when the Schedule 1 temperatures cannot be met, a Schedule 2 temperature regime, which is only slightly more detrimental to salmonids, is attempted. When Schedule 2 temperatures cannot be met, the process continues cycling downward through a series of 48 total schedules to the next slightly more detrimental temperature regime for the critical (spring-fall) months. This continues until a schedule of temperature targets, which is considered the least detrimental (to salmonids) regime feasible under existing conditions (i.e., current reservoir storage, available cool water pool, Delta inflow needs, air temperatures, and other determinants) can be met for the year. In many years, including in 2001, cool water availability is limited or depleted early in the seasonal period, thus a lower and less preferred temperature target schedule for must be adopted for salmonids.

In addition to the ATSP, NMFS has issued an interim Biological Opinion for Central Valley Project operations which includes an objective not to exceed a water temperature of 65^0F in the LAR at Watt Avenue throughout the year. This criterion is aimed at preservation of juvenile steelhead rearing habitat. Excessive water temperatures are considered to be the most significant stressor affecting juvenile steelhead in the river. Juvenile steelhead remain in the river throughout the year, whereas juvenile salmon emigrate from the river within, at most, a few months after hatching. Low over-summer survival of steelhead is believed to be the cause of the apparent low numbers of naturally-spawned steelhead which return annually to the river. Most of the river's returning steelhead are of hatchery origin.

Impacts of Excessive Water Temperatures

The detriments of excessive water temperatures to salmonids can be in the form of direct mortality to adults, juveniles, and eggs when water temperature index thresholds are greatly exceeded and/or exceeded for extended periods. In addition, a number of chronic, sub-lethal and indirect effects of high water temperatures, which are nevertheless sometimes population-limiting factors, are experienced which include the following:

- Causing smaller fry to be produced, which have lower survival due to increased vulnerability to predation, reduced overwinter survival, and alterations of their downstream migration timing;
- Causing poor body condition, which increases susceptibility to predation and diseases;
- Increasing food requirements and thus intra-and inter-specific competition for available feeding stations and food supplies;
- Causing premature seaward migration from the river, which causes fish to be ill-prepared physiologically to survive in a saline environment;
- Delaying the onset of salmon spawning in the fall, causing reduced egg production and fertility, greater egg retention, and increased embryonic abnormalities, in addition to the direct pre-spawning mortality of the returning adults; and
- Crowding spawning salmon into the uppermost LAR reaches where water is the coolest, causing spawning nest (redd) superimposition, which also reduces productivity.

Water Temperature Solutions

Recently, several structural and operational measures have been identified and preliminarily evaluated for their utility to help alleviate LAR water temperature problems for salmonids. Two broad approaches examined were: (a) increasing cool water volumes behind the two dams and/or (b) improving access to and management of such cool water to the river (USBR 2001, JSA 2001). Of five structural and five operational measures examined, the one with the most promise and ultimately selected as the preferred alternative is a structural measure involving modernization of the water outlet (temperature control) shutters of Folsom Dam (JSA 2001, HDR Engineering 2001). Folsom Dam shutter modernization is being considered an ecosystem restoration measure for evaluation here because of its potential to help restore historical water temperature regimes needed to maximize the LAR's natural in-river anadromous salmonid production. As described above, these historical water conditions are no longer available to the river's fisheries.

The operation of and present problems with Folsom Dam's temperature control shutters have recently been described in detail by SWRI (2001a, 2001b), USBR (2001), JSA (2001) and SAFCA (2001). (If more than the brief overview provided here is desired, the reader should refer to these reports.)

(*References cited with regard to this restoration measure are: [1] Jones and Stokes Associates. 2001. Draft ecosystem restoration for fisheries/aquatic resources through water temperature reduction in the Lower American River. July 11. [JSA 00-350] Sacramento, CA. Prepared for the Sacramento Area Flood Control Agency, Sacramento, CA; (2) Sacramento Area Flood Control Agency. 2001. Technical Memorandum–Folsom Dam Temperature Shutters Study of Alternatives. July. Prepared by HDR Engineering, Inc. for SAFCA; (3) Surface Water Resources, Inc. 2001a. Temperature and fishery analysis of mechanized temperature control device at Folsom Dam. July 6. Prepared for SAFCA; (4) Surface Water Resources, Inc. 2001b. Draft Aquatic Resources of the lower American River: Baseline Report. July. Prepared for the lower American River Fisheries and Instream Habitat (Fish) Working Group; and (5) U. S. Bureau of Reclamation. 2001. Lower American River temperature improvement study function analysis report. January 8-12 workshop results*.)

Existing Shutter Operations and Problems

Folsom Dam's temperature control shutters are a series of large, solid metal plates or panels within metal tracks which can be lowered or raised to allow reservoir water to enter the three penstocks leading to the dam's power-generating turbines. After passing the turbines, the water empties into Nimbus Reservoir and subsequently into the LAR.

Each of the three power penstock intakes on the dam is enclosed in a housing that supports a set of 45 removable 13-ft-high shutter panels. Each group of 45 shutters is arranged in 5 vertical columns of 9 panels each. A varying number of shutters can be lifted up to draw water from various elevations within the reservoir, thereby controlling the temperature of water entering the LAR.

However, presently, there is no capability to raise each of the 45 shutters individually and independently. Instead, shutters are bolted together such that the nine shutters comprising each vertical column have a 3-2-4 configuration. This means that the top three panels are bolted together and are raised as a unit, followed by the next two panels as a unit, and the last four panels as a unit. This configuration allows for reservoir water to be drawn into the penstocks from four distinct elevation ranges (i.e., with no panel, lowest panels, two lowest panels, or all three panels [shutter groups] in place.)

The present 3-2-4 shutter configuration and operations (for controlling temperatures) have a number of drawbacks and problems which are ultimately detrimental to the river's salmonid fisheries as follows:

! Each shutter change is labor intensive, requiring a three-person crew for completion. Often, because of scheduling conflicts with other duties of the crew, needed temperature changes are either delayed or foregone completely;

! Each shutter change is time-consuming, requiring 8-12 hours, sometimes spread over a 2-day period, which further delays the swift implementation of needed changes;

! Each shutter change causes traffic delays and stoppage across the Folsom Dam Road, a heavily traveled corridor. As a result, there is often pressure on operators to delay or forego changes.

! Due to the various constraints, usually only about 3-5 shutter modifications can actually be made during any given critical temperature season, whereas optimal temperature management for salmonid benefits might necessitate some multiple of this number of changes;

! Some amount (as yet unquantified) of cool water is believed to be lost annually from leakage occurring at or around the existing shutters and their related structural features. This is cool water that could otherwise be available for fisheries maintenance.

! Each shutter change is at best a rather coarse action, which means that often, much more cool water must be released to achieve a particular temperature objective than would be necessary with a more efficient, high-operational-flexibility system. Again, this results in wasted cool water that could otherwise benefit salmonids later in the same temperature management season. The inefficiency clearly results in some subsequent within-season temperature objectives failing to be met. In addition, the present system results in frequent severe temperature "spikes" both upwards and downwards, which are unnatural and may cause detrimental impacts to fish and/or the river's aquatic food base.

Alternatives Evaluated

Alternative 1, the preferred alternative selected by JSA (2001), is to modify the shutter housings to allow each shutter to be raised and lowered individually. One exception is that, because of flow limitations into the penstocks, each of the bottom two shutters would be operated as a single unit. The resulting new shutter configuration would thus be 1-1-1-1-1-1-1-2, or 7(1)-2, compared to the current 3-2-4 configuration. The new configuration would provide the greatest possible operational flexibility using the existing shutters, allowing the reservoir withdrawals to occur at 13-ft intervals. This would create essentially the same operational flexibility as a truly unlimited shutter positioning and control scheme.

The 7(1)-2 project could be built for either manual (Alternative 1A) or automated (Alternative 1B) shutter change operation. Although the automated system would have higher construction cost, annual operation cost would be substantially lower than for manual operation (HDR Engineering 2001, JSA 2001).

Alternative 2 evaluated here would involve the same kind of shutter housing modifications, except that a less flexible 1-1-2-2-3 configuration would be created. The 1-1-2-2-3 configuration has been proposed as mitigation for the reoperation of Folsom Reservoir for Sacramento area flood control by SAFCA. This configuration would allow for selection of six different release elevations instead of the present four. However, shutter changes would still be accomplished manually, as now. While greater temperature management flexibility would be achieved with the 1-1-2-2-3 shutter configuration than with existing shutter facilities, the 1-1-2-2-3 system would have considerably less temperature management flexibility and benefits than the proposed Alternatives 1A or 1B systems.

HEP Overview

This restoration measure was brought to consideration by the Corps and SAFCA after the HEP applications for the four terrestrial restoration sites had been completed. Thus, these four earlier HEPs were designed, conducted and analyzed without any forethought as to how the procedures might be effectively modified for comparable application to shutter modernization alternatives. Nonetheless, a HEP application for the shutter modernization alternatives would clearly be a useful adjunct to an otherwise largely qualitative analysis of alternatives. In addition, the Corps strongly desires HEP results for the shutter modernization alternatives to facilitate their required incremental cost analyses as were done for the other restoration measures. This in turn would aid in assigning preference rankings among the five restoration measures.

The Corps time frame for completion of a HEP application for the shutter modernization measure was extremely short. This precluded any new data or information from being generated, with the exception of a brief new HSI word model which was developed. Otherwise, only existing data and information as provided in the JSA (2001) and SWRI (2001a) reports was utilized.

The Service cautions that this HEP application is only for the purpose of very broad planning comparisons, primarily among the five broad restoration measures which are being considered and secondarily among the three shutter modernization alternatives. Assuming any higher level of utility or that the numbers generated in the HEP are more than simply broad indicators of overall habitat value would be both unrealistic and unjustified.

Salmon Mortality Modeling Results. SWRI (2001a) used a combination of existing LAR modeling tools, with appropriate modifications, to derive estimates of the annual mortality to early-life-stage chinook salmon that would occur under the various proposed shutter configurations (*see* SWRI 2001a for detail). The models that SWRI (2001a) used produced outputs suitable only for comparative planning purposes, and not for predicting actual in-river conditions at specific times and locations. Thus, these salmon mortality data are not definitive absolute values, but merely broad indicators providing "reasonable detection limits" of changes and general ranges that would be expected.

Only salmon mortality results were derived because a similar model of steelhead mortality was not available. However, SWRI's (2001a) modeling analyses were completed in a manner assuming the "best" year around ASTP-derived and species-balanced water temperature objectives for both salmon and steelhead. Thus, benefits for salmon often equate with benefits for steelhead. Otherwise, a planning effort (for water temperatures) directed only at the summer needs of juvenile steelhead would often result in severely depleted cool water reserves needed by fall-spawning adult salmon. Conversely, planning aimed mostly at the water temperature needs of fall salmon would often result in severe impacts to juvenile steelhead during summer.

SWRI's (2001a) salmon mortality data (Table 13) were used in concert with other qualitative results and findings they presented to derive an HSI (Habitat Suitability Index) for use here in the HEP application. HSIs for the HEP were derived using the word model presented below. SWRI's (2001a) mortality estimates for salmon (Table 13) are given for only three "representative" water year-types: "favorable," "moderate," and "adverse" in which the modeled ATSP temperature schedules would generally correspond with favorable, moderate, and adverse temperature regimes for salmonids during the critical spring-fall temperature management period. In assigning HSIs using the word model presented below, it was assumed that each of these three year-type classifications used by SWRI (2001a) occurred in roughly one-third of all water years.

HSI Word Model. This word model is applicable to only the two shutter modernization alternatives (1A, 1B) being considered and the projected 1-1-2-2-3 system (Alternative 2) which has been proposed by SAFCA as mitigation for Folsom Reservoir reoperation for flood control. Model output is intended to be the *increase* in-river production of naturally spawning and rearing salmonids which would occur in comparison to the existing 3-2-4 manually-operated shutter condition. The HSI is determined by selecting the word description below which best fits the conditions which would be expected to occur, based on the SWRI (2001a) analyses, including

Table 13. Estimated (from modeling) annual early-life-stage salmon mortality (%) in relation to various water temperature shutter control configurations and methods at Folsom Dam, by general water year-type (*from* SWRI 2001a).

GENERAL WATER YEAR-TYPE	SHUTTER CONFIGURATION AND OPERATION MODE			
	Existing (Man.) 3-2-4	Projected (Man.) 1-1-2-2-3	Modernized (Man.) 7(1)-2	Modernized (Auto.) 7(1)-2
Favorable	14.3	8.7(+5.6)	5.9(+8.4)	5.2(+9.1)
Moderate	10.1	11.9(-1.8)	6.1(+4.0)	6.6(+3.5)
Adverse	16.2	20.0(-3.8)	13.6(+2.6)	9.0(+7.2)

the modeled salmon mortality results. This model is ultimately for generating HEP results which will facilitate broad planning comparisons of relative desirability from a biological perspective among the five potential ecosystem restoration measures. It has no use or purpose beyond this limited objective. The word model is referred to as the "temperature improvement" evaluation species.

<u>Temperature Improvement Word Model (The "best fit" description is selected)</u> **<u>HSI</u>**

Compared to existing conditions, with Folsom Reservoir's temperature control shutters operated manually and in their present 3-2-4 configuration, the projected change(s) would:

1. In a majority of years, (A) *adverse water temperatures and water temperature fluctuations would be improved for juvenile salmonids throughout the May-November period, resulting in significant increases of juvenile salmon and steelhead survival* 1.0

2. In a majority of years, (B) *adverse water temperatures during October-November, adverse water temperature fluctuations during July-September, and overall mortality of juvenile salmonids would all be incrementally improved, while maximum water temperatures during May-June would not be significantly increased to the detriment of juvenile salmonids* 0.7

3. In roughly one-fourth to one-half of years, A (above) would occur 0.5

4. In roughly one-fourth to one-half of years, B (above) would occur 0.3

5. In a few, but less than one-fourth of years, either A or B (above) would occur 0.2

6. No significant water temperature changes would occur in any water years 0.0

Habitat Acreage. A conservative estimate of the linear amount of LAR aquatic habitat that would benefit from the improved temperature management actions was assumed to be the LAR from Nimbus Dam downstream 13 miles to Watt Avenue. Watt Avenue was the reference point for the water temperature modeling conducted by SWRI (2001a). However, often, water temperature benefits achieved at Watt Avenue would translate into incremental improvements downstream of Watt Avenue as well, depending on prevailing conditions. Thus, the 13 miles is a conservative estimate.

In addition, an estimate of the average width of the river in this 13 miles during the annual temperature management period was needed. First, based on data in SWRI (2001b), it was determined that the mean monthly post-1956 (Folsom and Nimbus dams completed) flow in the LAR for the critical temperature control months of April-November is about 2,600 cfs (cubic feet/second). Next, based on a systematic sample of 25 river surface-width cross sections measured from aerial photographs of the river taken at a flow of about 3,000 cfs, it was determined that the average April-November river width in the Nimbus-Watt Avenue reach is about 286 feet. Multiplying the average reach width by its length yields a riverine surface area estimate of 451 acres during the annual temperature management period. This is the value used in the HEP, and it is a conservative estimate due mainly to the conservative estimate of river length.

Relative Value Indice(RVI). Temperature improvement was assigned the highest RVI of 1.0, consistent with its very high potential to assist in recovery of the federally listed Central Valley steelhead and the federal candidate for listing, fall-run chinook salmon. Temperature improvement would also greatly assist in achieving the 1992 Central Valley Project Improvement Act goal of doubling (compared to a 1967-91 baseline) the natural production of anadromous salmonids in the Central Valley, including the LAR.

Adjustment for Number of Evaluation Species. Each of the HEP applications for the four terrestrial restoration sites had from four (Woodlake site) to six (Urrutia, Bushy Lake and Arden Bar sites) evaluation species. Often these evaluation species occurred on the same acreages, such that their habitat values became cumulative in the HEP accounting for a particular site. This cumulative accounting was especially true for the CA vole, Owl FV and Owl CRV evaluation species, which overlapped on about three-fourths of all the terrestrial restoration site habitat acreages.

Therefore, to normalize the shutter modernization HEP data for more direct comparison with the terrestrial HEP results, an additional adjustment factor to the RVI was deemed necessary. The adjustment factor selected was 3.5. This factor was considered a reasonable but conservative value, since the other HEPs had from four to six evaluation species. In other words, the RVI of 1.0 for temperature improvement related to shutter modernization was multiplied by 3.5 in the process of deriving AAAHUs from AAHUs. This procedure essentially allowed the shutter modernization HEP to represent 3.5 evaluation species. Ample justification for this procedure is that the temperature benefits associated with shutter modernization apply to more than just salmon and steelhead. It can reasonably be argued that the LAR's aquatic food base for fisheries would benefit from reductions in temperature spiking and that this in turn would benefit foraging for two other of the river's important species–striped bass and American shad. In addition, American shad spawning success and production in the LAR could also benefit from reductions of temperature spikes.

Target Years and Futures Predictions. Temperature management benefits to the river associated with temperature control shutter modernization would be immediate as soon as the construction was completed. In addition, unlike actions such as planting riparian vegetation, the maximum habitat-value gains would not only be achieved immediately but would remain relatively stable over the project life. Therefore, over the 50-year HEP analysis period, varying target years and futures predictions were not necessary. HUs in any one year is simply the product of the area (451 acres) and the HSI. AAHUs is the same value as the HUs. And AAAHUs is the product of AAHUs X 3.5.

Results and Discussion

The "best fit" of the word model is that modernization of the shutters into an automatic 7(1)-2 regime (Alternative 1B) would have an associated HSI of 0.7. This would result in 315.7 HUs in any one year and 315.7 AAHUs (451 acres x 0.7 HSI). A net gain of habitat value of 1,105.0 AAAHUs would thus accrue for an average gain of 2.45 AAAHUs/acre.

The 2.45 AAAHUs/acre gain of habitat value of Alternative 1B compares to overall average net habitat-value gains (for the better of the two alternatives) of 0.31/acre at the Woodlake site, 0.52/acre at the Urrutia site, 0.29/acre at the Bushy Lake site, and 0.35/acre at the Arden Bar site. Thus, a conservative estimate (due to the conservative evaluation species adjustment of 3.5 and conservative water surface acreage estimate) is that the shutter modernization option would be about 5-8 times more effective per acre in creating new habitat value than the four terrestrial restoration options.

In addition, Alternative 1B shutter modernization would provide the largest areal extent of habitat improvement–at least 451 acres of LAR riverine area, versus a maximum (for the larger of the two alternatives) of 68-193 acres of terrestrial habitat improved under the four terrestrial restoration options.

However, as discussed earlier in the terrestrial analyses, a few of the individual restoration measures at the four terrestrial sites would accrue higher habitat-value gains than the averages for the sites considered as a whole. For example, at the Woodlake site, improvements to the two stranding pits would result in gains of 0.90 and 0.86 AAAHUs/acre, respectively. At the Urrutia site, the best overall measure involving riparian forest re-creation would result in a gain of 1.19 AAAHU/acre. At the Bushy Lake site, the best measure, also involving riparian forest re-creation, would produce a gain of 0.77 AAAHUs/acre.   And finally, the highest-gaining measure at the Arden Bar site, involving creation of a small shallow aquatic area, would also result in a gain of 0.77 AAAHUs/acre. Compared in this manner, and without consideration of costs, the temperature shutter modernization option Alternative 1B is still clearly and unequivocally the superior restoration approach of the five broad measures being considered. However, just as clearly, some the terrestrial restoration measure components are still highly desirable.

The “best fit” HSIs for Alternative 1A (manual 7[1]-2 system) and Alternative 2 (1-1-2-2-3 manual operation), would be 0.5 and 0.2, respectively. Thus, Alternative 1A would result in 225.5 HUs and AAHUs, an overall gain of 789.25 AAAHUs, and a net gain of 1.75 AAAHUs/acre. The comparable estimates for Alternative 2 would be 90.2 HUs and AAHUs, an overall gain of 315.7 AAAHUs, and a net gain of 0.70 AAAHUs/acre. Thus, both of these alternatives would be far less effective than Alternative 1B and much more similar to the results that would be obtained via the four terrestrial restoration options.

Alternative 1B shutter modernization would clearly be the superior alternative based on the HEP results. However, decision makers also need to consider a number of other benefits of Alternative 1B shutter modernization not factored into the HEP accounting, which would make its implementation even more desirable:

- The greatly improved shutter management capability would result in both better water temperature management and cool water savings when river flows must be unexpectedly ramped up to meet Delta water quality needs or for other purposes, since with higher flows, in-river warming is less and cool water release requirements could be proportionally (and much more quickly and efficiently than now) reduced;

- The antiquated operations and control of LAR water temperatures represent a long-term, severe impact of Folsom Dam that can and should be alleviated using 21st century technology, to allow “real time” temperature monitoring and micro-adjustments based on actual fishery needs and system conditions;

- Both the Nimbus (salmon and steelhead) and American River (trout) fish hatcheries would likely benefit from reduced mortalities and chronic effects of periodic high water temperatures on their broodstock and offspring;

- The coldwater fishery of Folsom Reservoir, which includes both rainbow trout and king salmon, could possibly benefit due to warm-seasonal increase in the size of or seasonal duration of cold water pool behind the Folsom Dam (this potential benefit requires further analysis, however);

- There would be more flexibility to respond to power generation needs without compromising or impacting LAR temperature needs and requirements; and

- The LAR ecosystem and all or most of the fish and other aquatic organisms it supports would benefit by this significant step towards reestablishing the more favorable water temperature regimes under which they evolved.

Construction methods for shutter modernization have as yet only been cursorily described. The Service assumes that operations of the existing shutters would not be curtailed or otherwise detrimentally impacted during the construction period, and that any construction-related turbidity, blasting, drilling, use of chemicals and abrasives, and other actions during in-or out-of-water work would be appropriately minimized and mitigated. The Service is reserving the right to analyze these aspects of the Alternative 1B shutter modernization option in greater detail after the construction methods and procedures are fully known and described.

Conclusions

Assuming that: (1) any additional planning studies and analyses done on the Alternative 1B shutter modernization option support preliminary findings herein; and (2) no significant detrimental impacts to the LAR's resources are subsequently revealed related to the actual construction aspects of shutter modernization, the Service would strongly endorse and support construction of this action. However, the Service believes that such modernization must include the necessary automated operational capability for the full benefits of the action to be achieved. We would likely not support implementation of either Alternative 1A or 2. Shutter modernization to automated mode (Alternative 1B) should be given highest priority for implementation of the five ecosystem restoration options which are presently evaluated within this report.

FISH AND WILDLIFE SERVICE RECOMMENDATIONS RELATIVE TO THE FIVE RESTORATION OPTIONS

The following recommendations are preliminary, based on the habitat values and qualitative analyses presented herein, and the identified constraints. There has been not been any consideration of, or adjustments for, the monetary costs that the various actions would involve per unit area. As costs are factored into the equation, through the Corps' incremental cost analyses and other planning techniques, our recommendations may be subject to some modification. However, in the interim, the Service recommends that the Corps (and its local sponsor, SAFCA):

- Vigorously pursue implementation of the Folsom Dam automated 7(1)-2 shutter modernization option (Alternative 1B) in place of the 1-1-2-2-3 manual operation scheme previously proposed as mitigation for Folsom Reservoir reoperation, and consider the 7(1)-2 modernization option Alternative 1B as the top priority among the five restoration options evaluated herein.

- Also pursue implementation of a restoration alternative at *each* of the four terrestrial sites, focusing on the higher-habitat-value-gaining preliminary conceptual Alternative 1 for each site (except Alternative 3 at Bushy Lake), or any other materially and significantly similar alternative as may be developed by combining the measures and polygons (habitat patches) evaluated herein using the Corps' incremental analysis and/or other planning techniques.

- To the extent funding, land acquisition, or other constraints ultimately limit the number of the four terrestrial sites that can be restored, select sites for implementation based on their relative habitat- and ecosystem-value potential rates of gain in order (from highest to lowest priority for restoration) as follows: Urrutia site, Arden Bar site, Woodlake site, and Bushy Lake site.

- Ensure that potential impacts to elderberry plants and VELB could and would be fully minimized and appropriately offset using Service conservation guidelines for all terrestrial alternatives, but especially for any proposed at the Bushy Lake and Arden Bar sites.

- Include in any restoration alternatives proposed for implementation at the Woodlake, Urrutia, and Bushy Lake sites, not less than 63, 56, and 31 acres, respectively, of grassland restoration.

- To the extent that restoration intensity must be curtailed and limited for any reasons at the four terrestrial sites, focus first on the highest habitat-and ecosystem-value gaining options, as follows (and in descending order): Woodlake–measures 16 and then 13; Urrutia–measures 6 + 7 (RFO1), 13, and 15; Bushy Lake–measures 13, 15, 18, and 25 altogether; and Arden Bar–measures 14, 22, and 23 altogether.

- To the extent any funding or other constraints limit the number of patches of riparian forest and various kinds of oak woodlands that can be created at any of the four terrestrial sites, select the patches for implementation in descending order of their habitat-value gains as shown in Tables 5, 8, 10-10a, and 12 for the Woodlake, Urrutia, Bushy Lake, and Arden Bar sites, respectively.

! For any restoration alternatives proposed for implementation at any of the four terrestrial sites, include as part of the project, detailed long-term monitoring and remediation plans as well as adaptive management guidelines and policies, such as SAFCA currently uses for monitoring and evaluating mitigation along the LAR for impacts from recent bank protection completed for flood control. In addition, implement Alternative 3 for the Bushy Lake site only with a staged construction/operation and intensive contaminant monitoring as described above in the Alternative 3 preliminary HEP analysis.

! Provide any more detailed (or significantly modified) plans, specifications, and operational criteria as the Corps and SAFCA may develop for these four terrestrial sites and the shutter modernization option to the Service for further analysis and determination of whether our preliminary conclusions and recommendations presented here remain valid and acceptable to the Service.

APPENDIX A

HABITAT SUITABILITY INDEX MODELS FOR:

1. FOR SEASONAL FLOODPLAIN HABITAT OF THE LOWER AMERICAN RIVER;

2. OPEN WATER OF TWO POTENTIAL RESTORATION SITES; AND

3. EMERGENT MARSH OF TWO POTENTIAL RESTORATION SITES

AS USED IN THE ECOSYSTEM RESTORATION EVALUATIONS,
USING HABITAT EVALUATION PROCEDURES

JULY 2001

--Draft--

COMMUNITY-BASED HABITAT SUITABILITY INDEX MODEL FOR SEASONALLY INUNDATED FLOODPLAIN HABITAT, LOWER AMERICAN RIVER

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INTRODUCTION AND BACKGROUND

Flows in the 22-mile-long lower reach of the American River downstream of Folsom and Nimbus dams are highly controlled and manipulated, often bearing little semblance to natural historical flows. This reach is also largely and often closely confined by levees. Moreover, much of the remaining floodplain confined by the levees is a high terrace formed more than a century ago from hydraulic mining debris washing downstream. Due to the terrace's high elevation, it floods less frequently than it would under more natural conditions. Therefore, overall under existing conditions, occurrences of the natural dynamic processes of erosion, channel meander, and new habitat creation which are characteristic and essential to a healthily functioning riverine ecosystem are generally rare to nonexistent along the lower American River. Nonetheless, there may be significant opportunities for improvement of habitat condition and functioning, if not general ecosystem functioning, along this reach. Various entities are considering restoration and enhancement projects under several different authorities and programs. For example, the U.S. Army Corps of Engineers (Corps) is developing several possible "restoration" alternatives that could be presented to Congress for possible funding in conjunction with the Corps' flood control alternatives under its American River Watershed Investigation, Long-term Investigation; the Sacramento Area Flood Control Agency (SAFCA) would be the local project sponsor if this approach is pursued. SAFCA could also choose to pursue these or other similar restoration actions alone, through funding from its assessment district, CALFED, or other sources.

It is generally agreed that a guiding premise of any restoration actions for the lower American River should be the improvement of habitat conditions and values for threatened and endangered species. Indeed, one important premise in development of the preliminary model presented herein was the synthesis of variables and attributes believed important to the habitat needs of both Sacramento splittail, a federally-listed threatened native fish species, and several native anadromous salmonid fishes which are presently State and/or federally listed as either threatened or endangered.

Another community-based Habitat Suitability Index (HSI) model already exists for Shaded Riverine Aquatic (SRA) Cover of the lower Sacramento River and its associated sloughs (Fris and DeHaven 1993); this model was developed by the Fish and Wildlife Service (Service) in 1993. The SRA Cover model was considered, but not deemed appropriate, for application to seasonally inundated floodplain habitat along the lower American River. A primary problem is that the SRA Cover model focuses on habitat variables important along a permanently flooded stream bank and as such may not accurately portray habitat values over much broader and/or more diverse floodplain areas where inundation periodicity and duration vary dramatically. Rather than attempting to modify the existing SRA Cover model for applicability to seasonal floodplain habitat, an entirely new, but preliminary, HSI model as described herein was developed. This new model retains several of the features and underlying principles of the earlier SRA Cover model, however.

Although the Service has based this floodplain HSI model to a large degree on the needs of Sacramento splittail, there is no endorsement implied as to the model's applicability or utility for assessment of general impacts or mitigation needs of proposed projects which might adversely affect splittail. This is partly because the Service does not use Habitat Evaluation Procedures (HEP) as a tool for evaluation of impacts or conservation measure needs of listed species.

In addition, however, this model is highly preliminary in nature. It was developed in an expedited manner for the specific application described–evaluating the current lower American River restoration-oriented proposals being developed by the Corps and SAFCA In its present form, the model should facilitate objective comparisons of habitat value-versus-cost relationships among various restoration sites and among alternatives within the sites.

Broader and more general use of the model may be appropriate at some point in the future. However, this will necessitate future review and refinement. Several refinements have already been made based on the expert review recently provided by Pete Rawlings, Warren Shaul, Bill Mitchell, and Ken Casaday of Jones and Stokes (JSA), Inc., of Sacramento, California. The Service anticipates completion of additional expert review and refinements to the model in the future.

The basic concepts behind this model were initially developed by Steven Schoenberg of the Service's Sacramento Office, during November 2000. Mr. Schoenberg also provided expert review on earlier drafts of the model.

HABITAT SUITABILITY INDEX MODEL

Habitat Description

The model applies to seasonally inundated floodplain habitat, which includes gravel bars, side channels, backwaters, sloughs, overflow basins, low- and high-terrace lands, and general riparian zones which are temporarily flooded as river flows increase. Annual inundation is not a requisite; inundation frequency my be a low as once every few years.

Area of Applicability

This preliminary model was designed specifically for application along the lower American River from Nimbus Dam downstream to the Sacramento River confluence. As such, it may not be appropriate for other floodplain areas–even along the nearby lower Sacramento River or its distributary sloughs, or the Sacramento River's flood control bypasses–without modifications.

Following additional review and development as described above, the model should be more generally applicable to floodplains throughout low-elevation areas of the Sacramento River system. In short, variables included in any final model should reflect values of inundated floodplain to splittail and salmonids regardless of location.

In its present form the model *is*, however, intended to be used in both of the two major reaches of the lower American River–the Sacramento River backwater reach and the free-flowing reach. In the backwater reach, which extends upstream from the confluence with the Sacramento River to about River Mile (RM) 5, tidal influence occurs, surface elevations vary widely, and velocities are uniformly lower than in the free-flowing reach. The large differences in hydrology between the backwater and free-flowing reaches do necessitate slight differences in how the model variables are interpreted, however. These differences are given below in discussions of the variables.

Minimum Habitat Area

There is no minimum area of floodplain habitat to which the model should be applied. However, users should note that very small areas may result in very small and unwieldy Habitat Units (HUs) and Average Annual (AA) HUs in HEP applications. In such cases, HEP calculations and interpretations may be facilitated by uniformly applying some multiplicative factor to all acreage figures before calculations are made.

Model Output

Just as with the closely related SRA Cover model, this community-based model is assumed to broadly represent a synthesis of key habitat components of several fish and wildlife species which inhabit seasonal floodplain areas of the lower American River. The model is also assumed to assess the general trophic dynamic structure of the cover-type.

However, a more species-specific output, potentially with greater measurability, is: *the total number of juvenile and adult Sacramento splittail and juvenile salmonids temporarily supported on the floodplain prior to their safe passage downstream in any one season*. Juvenile fish of both types would be assumed present during their rearing and/or migration stages. Adult splittail would be assumed present during their pre-spawning foraging and/or spawning periods. Most such support of adult spittail would be expected to occur in the lower backwater zone, while support of juvenile salmonids would be expected to occur in both the free-flowing and backwater zones, with the latter area having a greater magnitude of use under certain high-flow conditions.

Verification Level

The Suitability Index (SI) methodologies were field-tested over about 5 days during December 2000 and January 2001. Brief computer simulations to derive HSIs under different hypothetical conditions were also conducted during the same period; a sample of these is provided below. No effort was made to collect empirical data to test the assumed relationship between HSI and the described model output in terms of fish numbers, however.

Pertinent Literature

The model is founded on well-known ecological principles and the knowledge and experience of the author and several expert reviewers. Time was of the essence in developing and applying the model to the restoration alternatives, and thus no effort was made to provide citations in support of any of the key assumptions or variable derivations. Nonetheless, the model was heavily influenced by the previous SRA Cover model (Fris and DeHaven 1993) and a recent report by the Service entitled "Impacts of Riprapping to Ecosystem Functioning, Lower Sacramento River, California" (USFWS 2000). The latter document contains dozens of references focusing on both salmonids and Sacramento splittail which are considered pertinent to the floodplain model.

Fris, M. B., and R. W. DeHaven. 1993. A community-based Habitat Suitability Index model for Shaded Riverine Aquatic Cover, selected reaches of the Sacramento River System. USFWS, Sacramento, California Office. 21pp.

USFWS. 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. USFWS, Sacramento Office. Prepared for U. S. Army Corps of Engineers, Sacramento District Office, as part of the USFWS's Fish and Wildlife Coordination Act Report and Biological Opinion, for Corps-proposed bank protection work. 40pp.

Model Overview

The underlying theory for the model is that habitat value for both splittail and juvenile salmonids is directly related to the amount of food and cover provided by the inundated floodplain, the duration of inundation, and the type and degree of hydrologic connection of the floodplain to the river. Hydrologic connection is represented by one variable and is assumed to generate about 38%(5/13) of HSI value. The food and cover element, which is derived from an aggregate of five variables, also is assumed to generate about 38% of HSI value. Inundation duration is also represented by a single variable which is assumed intermediate in importance, generating about 23%(3/13) of HSI value.

Each of the seven model variables is briefly described below. In addition, when deemed important, the purpose of the variable and/or the rationale behind its Suitability Index (SI) derivation are briefly stated.

Model Variables and Suitability Indices

All variables are expressed and measured in relation to the actual area (acreage) of seasonal floodplain being evaluated. Measurement methods are those actually employed in the initial trials and analyses using the model; other similar methods may work equally well. Measurements are to be taken when the floodplain is seasonally dry and any vegetation is in full vegetative leaf-out, if possible. RM 5 is the boundary between the backwater and free-flowing zones of the river.

V1= The number of woody tree or shrub species, each comprising 5% or more of the total vegetative canopy area during full vegetative leaf-out is:

Number	SI
0	0
1	0.3
2	0.6
$3	1.0

Diversity and abundance of habitat structure, cover, and food increase with increasing diversity of woody plant species. Measurement: Systematically placed line transects with systematically placed 25-ft radius circular plots. Count the number of woody species within each circular plot.

V2=The fraction of area covered by tree (>20 ft tall) canopy during full vegetative leaf-out is:

Fraction	SI
0	0
<1/3	0.3
1/3-2/3	0.6
>2/3	1.0

Insect drop, cover, and shade increase with increasing canopy cover. Measure: Same as for V1, except using 1 m^2 plots. Visually estimate canopy coverage within each plot.

V3=The number of horizontal planes (at 1, 5, and 6-15 ft above ground) in which total vegetative cover exceeds one-third during full vegetative leaf-out is:

Number	SI
0	0
1	0.3
2	0.6
3	1.0

Habitat value and functioning improve as vertical structure and density of cover in the water column increase. Measure: Same as for V2. Visually estimate canopy cover (i.e., either >or <1/3) within each plot, at 1 ft, 5 ft, and 6-15 ft above ground, facilitated by the use of a stadia rod or other measuring device to determine each of the three height-above-ground categories.

V4=The predominant bottom substrate is:

Substrate Type	SI
1. Uniform quarry rock or other standard form of riprap	0
2. Boulders (>30 inch) or other similar, hard, irregular material:	
a.And the site is in the river's backwater zone	0
b.And the site is in the river's free-flowing zone	0.3
3. River-run cobble rock (4-8 inch):	
a.And the site is in the river's backwater zone	0.3
b.And the site is in the river's free-flowing zone	0.6
Natural earthen materials, including sands, silts, clays, or gravels	1.0

Splittail are adapted to bottom feeding on invertebrates in slow-moving reaches where food is made available through flooding of small-to-fine natural substrates. Splittail also spawn in vegetation of slower reaches, whereas their utilization of hard rock substrates is unknown but generally believed to be quite low. More rearing of juvenile salmonids occurs in the free-flowing than backwater reach; these fish do benefit from diversity of hydrology and the cover associated with large, irregular substrate materials. Measurement: Same as for V2. Visually estimate the dominant substrate type within each plot.

V5=The percent of ground covered by detritus and organic debris just prior to flooding is:

Percent	SI
0-10%	0
>10-50%	0.3
>50%	1.0

Food increases with increasing organic debris and detritus. Measurement: Same as for V2. Visually estimate the category of percent coverage within each plot.

V6=The average annual cumulative duration of flooding is:

Duration	SI
<2 weeks:	
And the site is in the river's backwater zone-----------	0
And the site is in the river's free-flowing zone-------	0.1
2-4 weeks--	0.2
4-6 weeks--	0.6
>6 weeks---	1.0

Values of all habitat variables increases with increasing duration of flooding. Splittail require a minimum of 2 weeks to complete a spawning cycle. Measurement: Through analysis of hydrology records and flow-stage relationships from standard sources, including U. S. Geological Survey and Department of Water Resources stream gauge data.

V7=The hydrologic connectivity of the floodplain to the main river is:

Connection	SI
1. Significantly restricted, such that water surface elevation changes frequently do not directly, fully and immediately mirror the changes in the nearby channel and/or significant fish "stranding" may occur---------	0.2
2. Low-to-moderately restricted, such that water surface elevation changes generally, but not always, directly, fully and immediately mirror the changes in the nearby channel and/or low-to-moderate fish "stranding" may occur--	0.5
3. Unrestricted, such that water surface elevation changes always directly, fully and immediately mirror the changes in the nearby channel and fish "stranding" rarely, if ever, occurs--------------------------------------	1.0

The better the hydrologic connection of the floodplain to the river, the less the chances for loss of fish due to various "stranding" effects. However, even in pits and other deep overflow areas where stranding may at times be a problem, fish losses are likely rarely complete. Flows usually drop gradually to the level of the lowest overflow point, thus affording fish escape opportunities. Escape may also occur later in the same flood season when the river stage rises again. Measurement: This variable will often have to be a best-professional-judgement call of the involved biologist(s). If in doubt, assessment of likely water surface elevations should be based on appropriate flow and volume calculations.

HSI Calculation

The HSI is an arithmetic mean of the three model elements–the food and cover variables, the duration of inundation variable, and hydrologic connectivity variable. The following equation is used, based on the previously described relative weights of the three elements:

$$HSI=\frac{3(V1\text{-}V5) + 3V6 + 5V7}{13}$$

Example HSI Derivations

Descriptions of Theoretical Seasonal Floodplain Habitat Occurrences HSI

A. Existing fish stranding "pit," with moderate-to-high inundation, food, and cover--------0.54
B. Pit A, with hydrology improved to eliminate stranding---------------------------------------0.84
C. Existing fish stranding "pit," with low-to-moderate inundation, food, and cover---------0.31
D. Pit C, with hydrology improved to eliminate stranding---------------------------------------0.62
E. Existing fish stranding "pit," with high inundation, food, and cover values----------------0.69
F. Pit E, with hydrology improved to eliminate stranding--1.00
G. Floodplain area with high inundation value, low-to-moderate food and cover value, and no stranding---0.71

Theoretical Suitability Indexes for the Above Examples. HSI's Derived Using the Formula.

Example	V1	V2	V3	V4	V5	V6	V7
A	1.0	0.6	0.6	1.0	1.0	0.6	0.2
B	0.6	0.3	0.3	1.0	0.3	0.2	0.2
C	1.0	0.6	0.6	1.0	1.0	0.6	1.0
D	0.6	0.3	0.3	1.0	0.3	0.2	1.0
E	1.0	1.0	1.0	1.0	1.0	1.0	0.2
F	1.0	1.0	1.0	1.0	1.0	1.0	1.0
G	0.3	0.3	0.3	0	0.3	1.0	1.0

Application: This model was specifically developed for use at the proposed Arden Bar and Urrutia restoration sites along the lower American River, downstream of Nimbus and Folsom dams.

1. Depth Diversity Variable -The theory underlying this variable is that diversity in depth governs diversity in aquatic species, and diversity of use by avian species. Certain ducks are adapted for diving, while others rely on more shallow water to forage. Similarly, fish species diversity depends in part on depth diversity of the water body. For this variable, the category below is selected which best represents the site of interest. In selecting the category, the entire water body, whether vegetated or not, is considered. The concept in including the entire water body (i.e., areas converted to emergent marsh), is that these areas still function as shallow aquatic depth habitat.

a) Uniform, 95% deep only (>10 feet deep)...........................SI = 0.3
b) Uniform, 95% shallow only (<5 feet deep)........................SI = 0.5
c) Mixed, at least 10% shallow, the rest deep.........................SI = 1.0

2. Edge Cover Variable -The type and mixture of edge cover around a water body, irrespective of depth, determines the relative amounts of shelter, forage, and a source of detritus which enhance the functioning of open water to fish and wildlife. As with variable 1, the category is selected which best represents the overall condition of the edge of the water body of interest.

a) pavement...SI = 0
b) mowed grass/bare earth...SI = 0.1
c) unmowed grass...SI = 0.2
d) emergent marsh..SI = 1.0
e) shrubs (< 6 m tall)...SI = 0.5
f) mixed riparian..SI = 0.5
g) mix of scrub or riparian and emergent, each at least 10%...SI = 0.7

Calculation: The HSI is the geometric mean of the two variables

HSI = (V1 x V2)^1/2

Sample Calculations:

Urrutia, Baseline: V1 = 0.3 V2 = “b” = 0.2 **HSI = 0.24**
Urrutia, Future, alternative 1: V1 = 1.0 V2 = “d” = 1.0 **HSI = 1.0**
Urrutia, Future, alternative 2: V1 = 1.0 V2 = “g” = 0.7 **HSI = 0.84**
Arden Bar, Baseline: V1 = 0.5 V2 = 0.5 **HSI = 0.5**
Arden Bar, Future (either alternative): V1 = 0.5 V2 = “g” = 1.0 **HSI = 0.71**

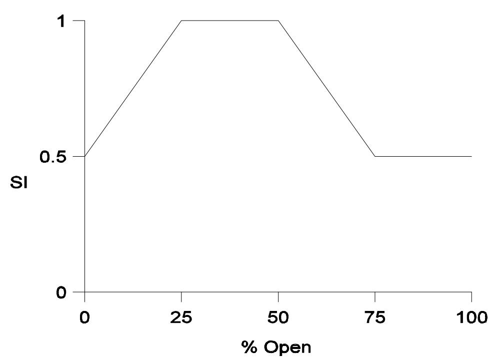
HSI Model for Emergent Marsh at Urrutia and Arden Bar
Proposed Ecosystem Restoration Sites,
Lower American River, California

Application: This model was specifically developed to evaluate concept plans for restoration at the proposed Arden Bar and Urrutia restoration sites along the lower American River downstream of Nimbus and Folsom dams.

1. Small Patch Discount Variable- Extremely small patches of emergent marsh may lack sufficient plant material or refugia from predators or human disturbance to function in proportion to their size. Therefore, the size category and appropriate SI are selected as follows:

a) > 0.2 acre...SI = 0.2
b) 0.2 - 1.0 acre...SI = 0.5
c) >1.0 acre...SI = 1.0

2. Relative Openness Variable-This variable considers the entire aquatic area (both open and vegetated). Intermediate degrees of openness in adjacent waters enhance the wildlife use and foraging quality of the marsh itself. Use the graph function based on percent of total area with emergent wetland.
3. Density Variable-Although preferences vary between avian species, moderately dense vegetation has more value than sparse vegetation, and is an indicator of temporal improvement with time after an initial restoration action.



a) sparse (<20% cover within emergent zone)..................SI = 0.2
b) intermediate (~50% cover within emergent zone.........SI = 0.5
c) moderately dense (>50 to 100% cover).........................SI = 1.0

4. Diversity Variable - The importance of diversity also varies between species; some, such as red-winged blackbird and marsh wren, benefit from dominance by cattails. Songbirds do not

prefer such dominance and would benefit from more diverse (and slightly less dense) marsh. Select one of the following which best fits:

a) 85% or more cattails..SI = 0.6
b) 50% cattails and 50% other species..................................SI = 1.0
c) 85% or more other species..SI = 0.5

Calculation: The HSI is the average of the openness, density, and diversity variables weighted by the discount variable.

HSI =V1 X (V2 + V3 + V4)/3)

Sample Calculation (Urrutia Alternative 1 or 2):

	TY2	TY10
V1	1	1
V2	0.5	0.5
V3	0.2	1
V4	1.0	0.6
HSI	**0.57**	**0.70**

Arden Bar Alternative 1, EW1-4; Arden Bar Alternative 2, EW1,5,6

	TY2	TY10
V1	0.2	0.2
V2	0.5	0.5
V3	0.2	1
V4	1.0	0.6
HSI	**0.11**	**0.14**

Arden Bar Alternative 1, EW5-6; Arden Bar Alternative 2, EW 2-4

	TY2	TY10
V1	0.5	0.5
V2	0.5	0.5
V3	0.2	1
V4	1.0	0.6
HSI	**0.28**	**0.35**

APPENDIX B

BASELINE (EXISTING) HABITAT CONDITIONS FOR
EVALUATION SPECIES, AS DETERMINED FROM
FIELD SAMPLING, DURING
JANUARY-MARCH 2001

AS USED IN THE ECOSYSTEM RESTORATION EVALUATIONS,
USING HABITAT EVALUATION PROCEDURES

APRIL 2001

Woodlake Restoration Site, 8.36-Acre Seasonal Wetland That Would be Converted to Either Riparian Forest (Alternative 1) or Improved Seasonal Wetland (Alternative 2), Existing Baseline Conditions, as Determined from Field Sampling and Hydrologic Analyses During December 2000.

Sample Plot No.	California Vole SIs			Plot HSI [1]	Owl FV SIs		Plot HSI [2]	SFCM - Derived SIs							Plot HSI [3]
	V_1	V_2	V_3		V_1	V_2		V_1	V_2	V_3	V_4	V_5	V_6	V_7	
1	1.00	0.85	1.00	0.95	1.00	1.00	1.00	0	0	0.30	1.00	0.30	0	0.20	0.20
2	1.00	0.55	1.00	0.85	1.00	1.00	1.00	0	0	0.30	1.00	0.30	0	0.20	0.20
3	1.00	0.40	1.00	0.80	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
4	1.00	0.32	1.00	0.77	1.00	1.00	1.00	0	0	0.30	1.00	0.30	0	0.20	0.20
5	1.00	0.55	1.00	0.85	1.00	0.88	0.94	0	0	0.30	1.00	1.00	0	0.20	0.25
6	1.00	0.40	1.00	0.80	1.00	0.80	0.89	0	0	0.30	1.00	1.00	0	0.20	0.25
7	1.00	0.55	1.00	0.85	1.00	0.53	0.73	0	0	0.30	1.00	1.00	0	0.20	0.25
8	1.00	0.40	1.00	0.80	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
9	1.00	0.55	1.00	0.85	1.00	1.00	1.00	0	0	0.30	1.00	0.30	0	0.20	0.20
10	1.00	0.20	1.00	0.73	0.98	0.45	0.66	0	0	0.30	1.00	1.00	0	0.20	0.25
11	1.00	0.32	1.00	0.77	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
12	1.00	1.00	1.00	1.00	1.00	0.87	0.93	0	0	0.30	1.00	1.00	0	0.20	0.25
13	1.00	0.20	1.00	0.73	0.98	1.00	0.99	0	0	0.30	1.00	0.30	0	0.20	0.20
14	1.00	0.32	1.00	0.77	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
15	1.00	0.50	1.00	0.83	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
16	1.00	0.02	1.00	0.67	0.10	0.35	0.33	0	0	0.30	1.00	1.00	0	0.20	0.25
17	1.00	0.20	1.00	0.73	0.98	0.45	0.66	0	0	0.30	1.00	1.00	0	0.20	0.25
18	1.00	0.20	1.00	0.73	0.98	0.82	0.90	0	0	0.30	1.00	1.00	0	0.20	0.25
19	1.00	0.20	1.00	0.73	0.98	1.00	0.99	0	0	0.60	1.00	0.30	0	0.20	0.22
20	1.00	0.20	1.00	0.73	0.98	0.87	0.92	0	0	0.30	1.00	1.00	0	0.20	0.25
21	0.63	1.00	1.00	0.88	1.00	0.18	0.42	0	0	0	1.00	1.00	0	0.20	0.23
22	0.63	1.00	1.00	0.88	1.00	0.16	0.40	0	0	0	1.00	1.00	0	0.20	0.23
23	1.00	0.55	1.00	0.85	1.00	1.00	1.00	0	0	0	1.00	0.30	0	0.20	0.18
24	1.00	0.50	1.00	0.85	1.00	0.87	0.93	0	0	0	1.00	1.00	0	0.20	0.23
25	1.00	0.55	1.00	0.85	1.00	1.00	1.00	0	0	0.30	1.00	0.30	0	0.20	0.20
26	1.00	0.32	1.00	0.77	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0	0	1.00	1.00	0	0.20	0.23
28	1.00	1.00	1.00	1.00	1.00	0.91	0.95	0	0	0.30	1.00	1.00	0	0.20	0.25
29	1.00	0.02	1.00	0.67	0.10	1.00	0.32	0	0	0.30	1.00	1.00	0	0.20	0.25
30	1.00	0.95	1.00	0.98	1.00	0.91	0.95	0	0	0.30	1.00	1.00	0	0.20	0.25
		Mean HSI		0.82	Mean HSI		0.86						Mean HSI		0.23

[1] $HSI = \dfrac{V_1 + V_2 + V_3}{3}$

[2] $HSI = (V_1 \times V_2)^{1/2}$

[3] $HSI = \dfrac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$

Woodlake Restoration Site, Polygon SW3 (Alternative 1) SW2 (Alternative 2) Existing Baseline Conditions for Seasonal Floodplain (Large "stranding pit") Habitat, as Determined from Field Sampling and Hydrologic Analyses During December 2000.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs		Plot	Owl CRV SIs		Plot	SFCM - Derived SIs							Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	HSI [2]	V_6	V_7	HSI [3]	V_1	V_2	V_3	V_4	V_5	V_6	V_7	HSI [4]
1*[1]	0.25	0.90	1.00	0.40	0.64	1.00	0.18	0.42	0	1.00	0	1.00	0	0	1.00	0.30	0.20	0.20	0.30
2	0.25	0.08	1.00	0.10	0.36	0.61	0	0	0.10	1.00	0.46	0.60	0	0	1.00	0	0.20	0.20	0.25
3	0	0	1.00	1.00	0.50	0	0	0	1.00	1.00	1.00	1.00	0.30	0	1.00	0.30	0.20	0.20	0.32
4	0.18	0.01	1.00	0.10	0.32	0.05	0	0	0	1.00	0	1.00	0	0.60	1.00	0.30	0.20	0.20	0.35
5	0.25	0.03	1.00	0.40	0.42	0.20	0	0	0	1.00	0	0.30	1.00	0	1.00	1.00	0.20	0.20	0.38
6	1.00	0.02	1.00	0.10	0.53	0.10	1.00	0.32	1.00	1.00	1.00	0.30	1.00	0	1.00	1.00	0.20	0.20	0.38
7	1.00	0.08	1.00	0.10	0.55	0.61	1.00	0.78	1.00	1.00	1.00	0.30	1.00	0.60	1.00	1.00	0.20	0.20	0.42
8	1.00	0.03	1.00	0.10	0.53	0.18	1.00	0.42	0	1.00	0	0.60	0.30	0	1.00	1.00	0.20	0.20	0.35
9	1.00	0.07	1.00	0.40	0.62	0.53	0.80	0.65	0.40	1.00	0.74	1.00	0.30	0.30	1.00	1.00	0.20	0.20	0.40
10	1.00	0.17	1.00	0.10	0.57	0.91	0.90	0.91	0.10	1.00	0.46	0.60	0.30	0.30	1.00	1.00	0.20	0.20	0.37
11	1.00	0.75	1.00	0.10	0.71	1.00	1.00	1.00	1.00	1.00	1.00	0.30	0	0.30	1.00	1.00	0.20	0.20	0.32
12	0.65	0.01	1.00	0.10	0.44	0.05	0	0	0.40	1.00	0.74	0.60	0.30	0.30	1.00	1.00	0.20	0.20	0.37
13	1.00	0.03	1.00	0.40	0.61	0.20	0.90	0.43	0.60	1.00	0.84	0.60	0.30	0.30	1.00	1.00	0.20	0.20	0.37
14	0.85	0.04	1.00	0.70	0.65	0.30	0.60	0.42	0.60	1.00	0.84	0	0	0.30	1.00	0.30	0.20	0.20	0.25
15	1.00	0.02	1.00	0.10	0.53	0.10	1.00	0.32	1.00	1.00	1.00	0.30	0	0.30	1.00	0	0.20	0.20	0.25
16	1.00	0.03	1.00	1.00	0.76	0.20	1.00	0.45	0	1.00	0	1.00	0	0.30	1.00	0	0.20	0.20	0.30
17*	0.18	0.61	1.00	0.10	0.47	1.00	0	0	1.00	1.00	1.00	1.00	1.00	0.60	1.00	1.00	0.20	0.20	0.48
18	0	0	1.00	1.00	0.50	0	0	0	0	1.00	0	0.60	0.60	0.30	1.00	1.00	0.20	0.20	0.37
19	0.48	0.75	1.00	0.10	0.58	1.00	0.15	0.39	1.00	1.00	1.00	1.00	1.00	0.60	1.00	1.00	0.20	0.20	0.48
20	0.65	0.05	1.00	0.10	0.45	0.45	0.20	0.30	0.10	1.00	0.46	1.00	1.00	0.30	1.00	1.00	0.20	0.20	0.45
21	1.00	0.47	1.00	0.10	0.64	1.00	0.90	0.95	0.10	1.00	0.46	1.00	1.00	0.30	1.00	1.00	0.20	0.20	0.45
22	0.48	0.10	1.00	0.10	0.42	0.87	0.40	0.59	0.40	1.00	0.74	0.60	0.30	0	1.00	1.00	0.20	0.20	0.35
23	1.00	0.40	1.00	0.40	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0.30	1.00	1.00	0.20	0.20	0.38
24	0.85	0.90	1.00	0.10	0.71	1.00	0.70	0.84	1.00	1.00	1.00	0.60	0.30	0	1.00	1.00	0.20	0.20	0.35
25	0.18	0.01	1.00	0.10	0.32	0.05	0	0	0.40	1.00	0.74	1.00	1.00	0.30	1.00	1.00	0.20	0.20	0.45
26	0	0	1.00	0.10	0.28	0	0	0	0.40	1.00	0.74	0.60	1.00	1.00	1.00	1.00	0.20	0.20	0.48
27	0.18	0.01	1.00	0.10	0.32	0.10	0	0	0.40	1.00	0.74	0.30	1.00	0.60	1.00	1.00	0.20	0.20	0.42
28	0	0	1.00	0.70	0.43	0	0	0	0	1.00	0	0.60	0.60	0.30	1.00	1.00	0.20	0.20	0.37
29	0.65	0.75	1.00	0.10	0.63	1.00	0.20	0.45	0	1.00	0	0.30	1.00	0.30	1.00	1.00	0.20	0.20	0.40
30	0	0	1.00	0.10	0.28	0	0	0	1.00	1.00	1.00	1.00	0.30	0.30	1.00	1.00	0.20	0.20	0.40
31	1.00	0.17	1.00	0.10	0.57	0.91	1.00	0.95	0.40	1.00	0.74	1.00	0.30	0.30	1.00	1.00	0.20	0.20	0.40
32	0.18	0.10	1.00	0.10	0.35	0.87	0	0	0.40	1.00	0.74	1.00	1.00	0.60	1.00	1.00	0.20	0.20	0.48
			Mean HSI		0.51	Mean HSI		0.36	Mean HSI		0.61						Mean HSI		0.38

* designates start of new transect.

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \times V_2)^{1/2}$

[3] $HSI = (V_6 \times V_7^2)^{1/3}$

[4] $HSI = \frac{\Sigma(V_1 - V_5) + 3V_6 + 5V_7}{13}$

Woodlake Restoration Site, Polygon SW4 (Alternative 1) SW3 (Alternative 2) Existing Baseline Conditions for Seasonal Floodplain (Small “stranding pit”) Habitat, as Determined from Field Sampling and Hydrologic Analyses During December 2000.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs		Plot	Owl CRV SIs		Plot	SFCM - Derived SIs							Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	HSI [2]	V_6	V_7	HSI [3]	V_1	V_2	V_3	V_4	V_5	V_6	V_7	HSI [4]
1*[1]	1.00	0.70	1.00	0.10	0.70	1.00	1.00	1.00	0.40	1.00	0.74	0	0	0.30	1.00	0.30	0	0.20	0.20
2	0.18	0.75	1.00	0.10	0.51	1.00	0	0	0.60	1.00	0.84	0	0	0.30	1.00	0	0	0.20	0.18
3	0.65	0.47	1.00	0.10	0.56	1.00	0.90	0.95	1.00	1.00	1.00	0	0	0.30	1.00	0.30	0	0.20	0.20
4	0.18	0.01	1.00	0.40	0.40	0.04	0	0	0.10	1.00	0.46	0	0	0.30	1.00	1.00	0	0.20	0.25
5	0.65	0.02	1.00	0.10	0.44	0.10	1.00	0.32	0.10	1.00	0.46	0.30	1.00	0.60	1.00	1.00	0	0.20	0.38
6	0.48	0.30	1.00	0.10	0.47	1.00	0	0	0.10	1.00	0.46	0.60	0	0.30	1.00	0.30	0	0.20	0.25
7	0	0	1.00	1.00	0.50	0	0	0	0.40	1.00	0.74	0.60	1.00	0.60	1.00	1.00	0	0.20	0.40
8*	0	0	1.00	0.40	0.35	0	0	0	0.40	1.00	0.74	0.30	1.00	0	1.00	0.30	0	0.20	0.28
9	0.65	0.01	1.00	0.70	0.59	0.04	0.70	0.17	1.00	1.00	1.00	0	0	0.30	1.00	0	0	0.20	0.18
10	0.65	1.00	1.00	0.10	0.69	1.00	0.60	0.78	0.40	1.00	0.74	0.30	0	0.30	1.00	0.30	0	0.20	0.22
11	0.18	0.83	1.00	0.10	0.53	1.00	0	0	1.00	1.00	1.00	0.60	1.00	0.60	1.00	1.00	0	0.20	0.40
12	0.85	0.75	1.00	0.10	0.68	1.00	0.20	0.45	1.00	1.00	1.00	0.60	0.60	0.30	1.00	0.30	0	0.20	0.29
13	1.00	0.01	1.00	0.10	0.53	0.02	1.00	0.14	0	1.00	0	0.30	1.00	1.00	1.00	1.00	0	0.20	0.41
14*	1.00	0.04	1.00	0.10	0.54	0.30	1.00	0.54	0	1.00	0	0.30	1.00	0.30	1.00	0.30	0	0.20	0.30
15	0	0	1.00	0.10	0.28	0	00	0	0	1.00	0	0.30	0	0.30	1.00	0.30	0	0.20	0.28
16	0.18	0.10	1.00	0.10	0.35	0.80	0	0	0.40	1.00	0.74	0.60	1.00	0.60	1.00	1.00	0	0.20	0.40
17	1.00	0.70	1.00	0.10	0.70	1.00	1.00	1.00	0.60	1.00	0.84	0.30	0	0	1.00	0	0	0.20	0.18
18	1.00	0.83	1.00	0.10	0.73	1.00	1.00	1.00	0.10	1.00	0.46	0	0	0.30	1.00	0.30	0	0.20	0.20
19	1.00	0.54	1.00	0.10	0.66	1.00	0.63	0.79	0.40	1.00	0.74	0.60	0	0	1.00	0	0	0.20	0.20
			Mean HSI		0.54	Mean HSI		0.38	Mean HSI		0.63						Mean HSI		0.27

* designates start of new transect.

[1] $\text{HSI} = \dfrac{V_1 + V_2 + V_3 + V_4}{4}$ [2] $\text{HSI} = (V_1 \times V_2)^{1/2}$ [3] $\text{HSI} = (V_6 \times V_7^{2})^{1/3}$ [4] $\text{HSI} = \dfrac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$

Woodlake Restoration Site, 2.60-Acre Seasonal Wetland to be Converted That Would Either an Improved Seasonal Wetland (Polygon SW2 - Alternative 1) or Grassland (Alternative 2), Existing Baseline Conditions, as Determined from Field Sampling and Hydrologic Analyses During December 2000.

Sample Plot No.	California Vole SIs			Plot	Owl FV SIs		Plot	SFCM - Derived SIs							Plot
	V_1	V_2	V_3	HSI [1]	V_1	V_2	HSI [2]	V_1	V_2	V_3	V_4	V_5	V_6	V_7	HSI [3]
1	0.33	0.82	1.00	0.72	1.00	0	0	0	0	0.30	1.00	0.30	0	0.20	0.20
2	0.65	0.68	1.00	0.78	1.00	0.45	0.67	0	0	0.30	1.00	0.30	0	0.20	0.20
3	0.50	0.96	1.00	0.82	1.00	0	0	0	0	0.30	1.00	0.30	0	0.20	0.20
4	1.00	0.96	1.00	0.99	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
5	1.00	0.96	1.00	0.99	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
6	1.00	1.00	1.00	1.00	1.00	0.91	0.95	0	0	0.30	1.00	0.30	0	0.20	0.20
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
8	1.00	0.96	1.00	0.99	1.00	0.35	0.59	0	0	0.30	1.00	1.00	0	0.20	0.25
9	1.00	1.00	1.00	1.00	1.00	0.75	0.87	0	0	0.30	1.00	0.30	0	0.20	0.20
10	1.00	0.95	1.00	0.98	1.00	0.91	0.95	0	0	0.30	1.00	1.00	0	0.20	0.25
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
12	1.00	0.91	1.00	0.97	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
13	1.00	0.95	1.00	0.97	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
14	1.00	0.81	1.00	0.94	1.00	1.00	1.00	0	0	0	1.00	1.00	0	0.20	0.23
15	1.00	0.81	1.00	0.94	1.00	1.00	1.00	0	0	0	1.00	1.00	0	0.20	0.23
16	1.00	0.96	1.00	0.98	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
17	1.00	0.91	1.00	0.97	1.00	1.00	1.00	0	0	0	1.00	1.00	0	0.20	0.23
18	1.00	0.91	1.00	0.97	1.00	0.83	0.91	0	0	0.30	1.00	1.00	0	0.20	0.25
19	1.00	0.92	1.00	0.97	1.00	1.00	1.00	0	0	0.30	1.00	1.00	0	0.20	0.25
20	0.50	0.88	1.00	0.79	1.00	0.32	0.57	0	0	0.30	1.00	1.00	0	0.20	0.25
		Mean HSI		0.94	Mean HSI		0.83						Mean HSI		0.23

[1] $HSI = \dfrac{V_1 + V_2 + V_3}{3}$ [2] $HSI = (V_1 \times V_2)^{1/2}$ [3] $HSI = \dfrac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$

Woodlake Restoration Site, Riparian Forest That Would Be Impacted on Westerly Portions of Polygons SAQ1 and SW1 (Alternative 1), as Determined from Field Sampling During January 2001.

Sample Plot No.	California Vole SIs				Plot HSI [1]	Owl FV SIs			Plot HSI [2]	Owl CRV SIs		Plot HSI [3]
	V_1	V_2	V_3	V_4		V_1	V_2	V_4		V_6	V_7	
1	1.00	0.80	1.00	0.10	0.73	1.00	1.00	0	1.00	1.00	0.95	0.97
2	1.00	0.27	1.00	0.10	0.59	1.00	0.85	0	0.85	0.40	0.95	0.71
3	1.00	0.80	1.00	0.10	0.73	1.00	0.55	0	0.55	0	0.95	0
4	1.00	0.80	1.00	0.10	0.73	1.00	1.00	0	1.00	0.40	0.95	0.71
5	0.30	0.05	1.00	0.10	0.36	0.40	0.37	0	0.15	0.60	0.95	0.82
6	1.00	0.35	1.00	0.10	0.61	0.70	1.00	0	0.70	0.10	0.95	0.45
7	1.00	0.40	1.00	0.10	0.63	1.00	1.00	0	1.00	0.40	0.95	0.71
8	0.65	0.02	1.00	0.10	0.44	0.03	0	0	0	0.60	0.95	0.82
9*	1.00	0.84	1.00	0.10	0.89	1.00	1.00	0	1.00	1.00	0.95	0.97
10	1.00	0.01	1.00	0.10	0.53	0.02	1.00	0.90	0.26	0.40	0.95	0.71
11	1.00	0.40	1.00	0.10	0.63	1.00	1.00	0	1.00	1.00	0.95	0.97
12	1.00	0.92	1.00	0.10	0.75	1.00	1.00	0	1.00	0	0.95	0
13	1.00	1.00	1.00	0.10	0.85	1.00	1.00	0	1.00	0	0.95	0
14	1.00	1.00	1.00	0.10	0.77	1.00	1.00	0	1.00	0	0.95	0
15	1.00	0.84	1.00	0.10	0.73	1.00	1.00	0	1.00	0	0.95	0
16	1.00	0.68	1.00	0.10	0.69	1.00	1.00	1.00	1.00	0	0.95	0
17	1.00	1.00	1.00	0.10	0.77	1.00	1.00	0	1.00	1.00	0.95	0.97
18*	1.00	0.68	1.00	0.10	0.69	1.00	1.00	0	1.00	1.00	0.95	0.97
19	0.17	0.01	1.00	0.10	0.32	0.02	0	0	0	1.00	0.95	0.97
20	0.34	0.25	1.00	0.10	0.42	1.00	0.10	0.50	0.60	0	0.95	0
21	1.00	0.25	1.00	0.10	0.66	1.00	1.00	1.00	1.00	0.40	0.95	0.71
22	1.00	0.02	1.00	0.10	0.53	0.20	0.65	0.40	0.53	0.40	0.95	0.71
23	0.80	0.01	1.00	0.10	0.47	0.01	1.00	0.05	0.06	1.00	0.95	0.97
24	0	0	1.00	0.10	0.43	0	0	0.80	0	0.40	0.95	0.71
25	1.00	0.05	1.00	0.10	0.61	0.50	0.20	1.00	1.00	0.40	0.95	0.71
26	1.00	0.01	1.00	0.10	0.53	0.02	1.00	0.10	0.12	0.10	0.95	0.45
27	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0.35	0.38	0.40	0.95	0.71
28*	0	0	1.00	0.10	0.43	0	0	0.80	0	0.10	0.95	0.45
29	1.00	0.27	1.00	0.10	0.59	1.00	1.00	0	1.00	0.10	0.95	0.45
30	1.00	0.04	1.00	0.10	0.53	0.30	1.00	0	0.30	0.10	0.95	0.45
31	1.00	0.25	1.00	0.10	0.59	1.00	1.00	0	1.00	0.10	0.95	0.45
32	1.00	0.75	1.00	0.10	0.71	1.00	1.00	0	1.00	0.40	0.95	0.71
33	1.00	0.01	1.00	0.10	0.60	0.01	1.00	1.00	1.00	0.10	0.95	0.45
34	1.00	0.25	1.00	0.10	0.66	1.00	1.00	0.40	1.00	0.60	0.95	0.82
35	0.62	0.48	1.00	0.10	0.55	1.00	0.60	0	0.60	1.00	0.95	0.97
			Mean HSI		0.61		Mean HSI		0.69	Mean HSI		0.58

* designates start of new transect.

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$, where $V_4 > 50\%$

[3] $HSI = (V_6 \times V_7^2)^{1/3}$

Woodlake Restoration Site, Non-Impacted Riparian Forest Polygons Under Baseline Conditions, as Determined from Field Sampling During January 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
19.081 Acre Mixed Riparian Forest - Southwest Perimeter												
1	1.00	0.25	1.00	0.10	0.66	1.00	1.00	0.40	1.00	0.60	0.95	0.82
2	1.00	0.75	1.00	0.10	0.71	1.00	1.00	0	1.00	0.40	0.95	0.71
3	1.00	0.04	1.00	0.10	0.53	0.30	1.00	0	0.30	0.10	0.95	0.45
4	0	0	1.00	0.10	0.43	0	0	0.80	0	0.10	0.95	0.45
5	1.00	0.05	1.00	0.10	0.61	0.50	0.20	1.00	1.00	0.40	0.95	0.71
6	0.80	0.01	1.00	0.10	0.47	0.01	1.00	0.05	0.06	1.00	0.95	0.97
7	1.00	0.25	1.00	0.10	0.66	1.00	1.00	1.00	1.00	0.40	0.95	0.71
8	0.17	0.01	1.00	0.10	0.32	0.02	0	0	0	1.00	0.95	0.97
9	1.00	1.00	1.00	0.10	0.77	1.00	1.00	0	1.00	1.00	0.95	0.97
10	1.00	0.84	1.00	0.10	0.73	1.00	1.00	0	1.00	0	0.95	0
11	1.00	1.00	1.00	0.10	0.85	1.00	1.00	0	1.00	0	0.95	0
12	1.00	0.40	1.00	0.10	0.63	1.00	1.00	0	1.00	1.00	0.95	0.97
13	1.00	0.84	1.00	0.10	0.89	1.00	1.00	0	1.00	1.00	0.95	0.97
14	1.00	0.40	1.00	0.10	0.63	1.00	1.00	0	1.00	0.40	0.95	0.71
15	0.30	0.05	1.00	0.10	0.36	0.40	0.37	0	0.15	0.60	0.95	0.82
16	1.00	0.80	1.00	0.10	0.73	1.00	0.55	0	0.55	0	0.95	0
17	1.00	0.80	1.00	0.10	0.73	1.00	1.00	0	1.00	1.00	0.95	0.97
18	1.00	1.00	1.00	0.10	0.77	1.00	1.00	0	1.00	0	0.95	0
19	1.00	0.02	1.00	0.10	0.53	0.20	0.65	0.40	0.53	0.40	0.95	0.71
20	1.00	0.04	1.00	0.10	0.53	0.30	1.00	0	0.30	0.10	0.95	0.45
			Mean HSI		0.63		Mean HSI		0.70	Mean HSI		0.62
16.77 Acre Riparian Forest and Permanent Wetland												
1	0.65	0.01	1.00	0.40	0.52	0.01	0.20	0.50	0.50	1.00	0.88	0.92
2	0	0	1.00	0.10	0.28	0	0	0	0	0.40	0.88	0.68
3	0	0	1.00	1.00	0.50	0	0	1.00	1.00	1.00	0.88	0.92
4	0	0	1.00	0.40	0.35	0	0	0.20	0.20	1.00	0.88	0.92
5	1.00	0.61	1.00	0.40	0.75	1.00	1.00	0	1.00	0.60	0.88	0.78
6	0	0	1.00	0.10	0.28	0	0	0	0	1.00	0.88	0.92
7	1.00	0.02	1.00	0.10	0.53	0.01	1.00	0.50	0.51	0.40	0.88	0.68
8	0	0	1.00	0.10	0.28	0	0	1.00	1.00	0.40	0.88	0.68
9	0	0	1.00	0.10	0.28	0	0	0.78	0.92	1.00	0.88	0.92
10	1.00	0.05	1.00	0.10	0.54	0.40	1.00	0	0.40	0.60	0.88	0.78
11	0	0	1.00	0.40	0.35	0	0	1.00	1.00	0	0.88	0
12	1.00	0.05	1.00	0.10	0.54	0.40	1.00	0	0.40	0.60	0.88	0.78
13	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0.58	1.00	0.10	0.88	0.43
14	1.00	0.05	1.00	0.10	0.54	0.40	1.00	0	0.40	0.60	0.88	0.78
15	0	0	1.00	0.10	0.28	0	0	0.58	0.83	0.10	0.88	0.43

Non-Impacted Riparian Forest Polygons Under Baseline Conditions Continued.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
16	1.00	0.02	1.00	0.40	0.61	0.10	1.00	1.00	1.00	0.10	0.88	0.43
17	1.00	0.25	1.00	0.40	0.66	1.00	0.61	1.00	1.00	0.10	0.88	0.43
18	1.00	0.05	1.00	0.70	0.69	0.40	1.00	1.00	1.00	0	0.88	0
19	1.00	0.08	1.00	0.40	0.62	0.57	1.00	1.00	1.00	0.60	0.88	0.78
20	1.00	0.83	1.00	0.10	0.73	1.00	1.00	0	1.00	0	0.88	0
			Mean HSI		0.49		Mean HSI		0.66	Mean HSI		0.61
15.69 Acre Mixed Forest												
1	0	0	1.00	0.40	0.35	0	0	0.65	0.65	1.00	1.00	1.00
2	0.65	0.25	1.00	0.10	0.49	1.00	0.61	0	0.61	0.10	1.00	0.46
3	0.65	0.09	1.00	0.40	0.54	0.70	1.00	0.10	0.80	1.00	1.00	1.00
4	1.00	0.02	1.00	0.40	0.61	0.10	1.00	0.50	0.60	1.00	1.00	1.00
5	1.00	0.70	1.00	0.10	0.70	1.00	1.00	0	1.00	0	1.00	0
6	0	0	1.00	0.70	0.43	0	0	1.00	1.00	1.00	1.00	1.00
7	0	0	1.00	1.00	0.50	0	0	1.00	1.00	1.00	1.00	1.00
8	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0	1.00	0	1.00	0
9	0	0	1.00	1.00	0.50	0	0	0.67	0.88	1.00	1.00	1.00
10	0	0	1.00	1.00	0.50	0	0	0.18	0.57	1.00	1.00	1.00
11	0.65	0.09	1.00	0.10	0.46	0.70	0.61	0	0.43	0.60	1.00	0.84
12	0	0	1..00	0.40	0.35	0	0	0.18	0.57	0.40	1.00	0.74
13	0	0	1.00	0.10	0.28	0	0	0.30	0.67	0	1.00	0
14	0	0	1.00	0.10	0.28	0	0	0.30	0.67	0	1.00	0
15	0	0	1.00	0.10	0.28	0	0	0.65	0.65	1.00	1.00	1.00
16	0	0	1.00	0.70	0.43	0	0	1.00	1.00	0.60	1.00	0.84
17	0	0	1.00	0.10	0.28	0	0	0	0	1.00	1.00	1.00
18	0	0	1.00	0.10	0.28	0	0	0.08	0.08	0.10	1.00	0.46
19	0	0	1.00	0.70	0.43	0	0	1.00	1.00	0.40	1.00	0.74
20	0.48	0.54	1.00	0.10	0.53	1.00	0.87	0.20	1.00	0.60	1.00	0.84
			Mean HSI		0.44		Mean HSI		0.71	Mean HSI		0.70
12.22 Acre Oak Riparian Woodland - Northwest Corner												
1	0.85	0.01	1.00	0.10	0.49	0.01	0	0	0	1.00	0.64	0.74
2	0	0	1.00	0.70	0.43	0	0	1.00	1.00	0.60	0.64	0.63
3	0	0	1.00	0.10	0.28	0	0	0	0	1.00	0.64	0.74
4	1.00	0.01	1.00	0.10	0.53	0.01	1.00	0.65	0.66	0.10	0.64	0.35
5	1.00	0.01	1.00	0.10	0.53	0.06	1.00	0.65	0.71	0	0.64	0
6	1.00	0.01	1.00	0.70	0.68	0.01	1.00	0.50	0.51	0.10	0.64	0.35
7	0	0	1.00	0.10	0.28	0	0	0	0	0.60	0.64	0.63
8	0	0	1.00	0.40	0.35	0	0	0.30	0.67	1.00	0.64	0.74
9	0	0	1.00	1.00	0.50	0	0	0.50	0.50	1.00	0.64	0.74
10	1.00	0.01	1.00	0.10	0.53	0.06	1.00	0.20	0.26	0.60	0.64	0.63

Non-Impacted Riparian Forest Polygons Under Baseline Conditions Continued.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
11	0	0	1.00	0.10	0.28	0	0	0.10	0.10	0.10	0.64	0.35
12	0	0	1.00	0.10	0.28	0	0	0.50	0.50	1.00	0.64	0.74
13	0	0	1.00	0.10	0.28	0	0	0	0	0.60	0.64	0.63
14	0	0	1.00	0.70	0.43	0	0	1.00	1.00	0.10	0.64	0.35
15	0	0	1.00	1.00	0.50	0	0	1.00	1.00	0.10	0.64	0.35
16	1.00	0.04	1.00	0.10	0.54	0.30	1.00	1.00	1.00	0.10	0.64	0.35
17	1.00	0.17	1.00	0.10	0.57	0.86	1.00	1.00	1.00	0.10	0.64	0.35
18	0.25	0.07	1.00	0.10	0.36	0.50	0	0	0	0	0.64	0
19	1.00	0.09	1.00	0.10	0.55	0.70	1.00	0.20	0.90	0.10	0.64	0.35
20	1.00	0.05	1.00	0.40	0.61	0.40	1.00	1.00	1.00	0.10	0.64	0.35
			Mean HSI		0.45		Mean HSI		0.54	Mean HSI		0.47
9.66 Acre Mixed Riparian Forest - Southeast Corner												
1	1.00	0.07	1.00	0.40	0.62	0.50	1.00	0.50	1.00	0.10	1.00	0.47
2	0.65	0.01	1.00	0.40	0.52	0.03	0	0.20	0.20	0.40	1.00	0.74
3	1.00	0.01	1.00	0.10	0.53	0.01	1.00	0	0.01	0.40	1.00	0.74
4	0	0	1.00	1.00	0.50	0	0	0.67	0.88	0.10	1.00	0.47
5	1.00	0.25	1.00	0.40	0.66	1.00	1.00	0.65	1.00	0.10	1.00	0.47
6	1.00	0.01	1.00	1.00	0.75	0.03	1.00	0.20	0.23	0	1.00	0
7	0.18	0.01	1.00	1.00	0.55	0.03	0	0.20	0.20	0.40	1.00	0.74
8	1.00	0.70	1.00	0.10	0.70	1.00	1.00	0	1.00	0.10	1.00	0.47
9	1.00	0.01	1.00	0.40	0.60	0.03	1.00	0.65	0.68	0.60	1.00	0.84
10	1.00	0.03	1.00	0.40	0.61	0.20	1.00	0.50	0.70	0.40	1.00	0.74
11	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0.20	0.23	1.00	1.00	1.00
12	1.00	0.03	1.00	0.40	0.61	0.20	1.00	0.50	0.70	0.60	1.00	0.84
13	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0	1.00	0
14	1.00	0.01	1.00	1.00	0.75	0.03	1.00	0.58	1.00	1.00	1.00	1.00
15	0	0	1.00	0.10	0.28	0	0	0.58	0.84	0.60	1.00	0.84
16	0	0	1.00	1.00	0.50	0	0	0.50	0.79	0	1.00	0
17	1.00	0.47	1.00	0.70	0.79	1.00	1.00	0.65	1.00	1.00	1.00	1.00
18	0	0	1.00	0.10	0.28	0	0	0.18	0.57	0	1.00	0
19	1.00	0.83	1.00	0.40	0.81	1.00	1.00	0	1.00	1.00	1.00	1.00
20	0.48	0.03	1.00	0.10	0.40	0.20	0	1.00	1.00	0.60	1.00	0.84
			Mean HSI		0.59		Mean HSI		0.70	Mean HSI		0.61
4.42 Acre Upland Oak Savannah												
1	0.48	0.75	1.00		0.74	1.00	0.05		0.22			
2	1.00	0.54	1.00		0.85	1.00	0.30		0.55			
3	1.00	0.83	1.00		0.94	1.00	1.00		1.00			
4	1.00	0.40	1.00		0.80	1.00	1.00		1.00			
5	0.85	0.04	1.00		0.63	0.30	0		0			

Non-Impacted Riparian Forest Polygons Under Baseline Conditions Continued.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
6	0.85	0.07	1.00		0.64	0.50	0.87		0.66			
7	0.65	0.09	1.00		0.58	0.70	0.10		0.27			
8	0.18	0.61	1.00		0.60	1.00	0.20		0.45			
9	0.65	0.90	1.00		0.85	1.00	0.10		0.32			
10	0.48	0.09	1.00		0.52	0.70	0.78		0.74			
11	1.00	0.40	1.00		0.80	1.00	1.00		1.00			
12	1.00	0.10	1.00		0.70	0.78	1.00		0.88			
13	0.85	0.83	1.00		0.89	1.00	0.30		0.55			
14	0.18	0.04	1.00		0.41	0.30	0		0			
15	1.00	0.25	1.00		0.75	1.00	1.00		1.00			
			Mean HSI[4]		0.71		Mean HSI[5]		0.58			
4.15 Acre Riparian Forest and Permanent Wetland - Northeast Perimeter												
1	0.48	0.90	1.00	0.10	0.62	1.00	0.10	0	0.10	0.60	0.21	0.30
2	1.00	0.01	1.00	0.70	0.68	0.06	0.57	1.00	1.00	1.00	0.21	0.35
3	1.00	0.09	1.00	0.10	0.55	0.70	1.00	0.10	0.80	0.10	0.21	0.16
4	1.00	0.10	1.00	0.40	0.54	0.78	0.87	1.00	1.00	0.10	0.21	0.16
5	0.85	0.05	1.00	0.10	0.50	0.40	0	0.40	0.93	0.10	0.21	0.16
6	1.00	0.90	1.00	0.10	0.50	1.00	1.00	0	1.00	1.00	0.21	0.35
7	0	0	1.00	0.10	0.28	0	0	0.40	0.74	0.60	0.21	0.30
8	0	0	1.00	0.10	0.28	0	0	0.92	0.97	0	0.21	0
9	1.00	0.01	1.00	0.40	0.60	0.03	1.00	0.83	1.00	1.00	0.21	0.35
10	1.00	0.47	1.00	0.10	0.64	1.00	1.00	0.65	1.00	0.10	0.21	0.16
			Mean HSI		0.52		Mean HSI		0.85	Mean HSI		0.23
2.62 Acre Seasonal Wetland Vegetation and Riparian Scrub - Northeast Corner												
1	0.25	0.02	1.00	0.10	0.34	0.10	0	0.83	0.98	0.10	0.11	0.11
2	1.00	0.25	1.00	0.10	0.59	1.00	1.00	1.00	1.00	0.10	0.11	0.11
3	0.48	0.90	1.00	0.10	0.62	1.00	0.10	0	0.10	0.10	0.11	0.11
4	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	0.11	0
5	0.18	0.09	1.00	0.10	0.34	0.78	0	0	0	0.60	0.11	0.19
6	1.00	0.01	1.00	0.10	0.53	0.05	1.00	0	0.05	0.60	0.11	0.19
7	0	0	1.00	0.10	0.28	0	0	0.30	0.67	0	0.11	0
8	1.00	0.01	1.00	0.10	0.53	0.05	1.00	0.58	1.00	0	0.11	0
9	0.25	0.07	1.00	0.10	0.36	0.53	0	0.58	1.00	0.10	0.11	0.11
10	1.00	0.02	1.00	0.10	0.53	0.10	0	0.58	0.88	0	0.11	0
			Mean HSI		0.49		Mean HSI		0.67	Mean HSI		0.08
2.37 Acre Riparian Forest												
1	0	0	1.00	1.00	0.50	0	0	0.65	0.65	1.00	1.00	1.00
2	0	0	1.00	0.10	0.28	0	0	1.00	1.00	0.60	1.00	0.84
3	0	0	1.00	0.40	0.35	0	0	0.50	0.50	0.10	1.00	0.46

Non-Impacted Riparian Forest Polygons Under Baseline Conditions Continued.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
4	1.00	0.04	1.00	0.40	0.61	0.30	1.00	0.50	0.80	0.10	1.00	0.46
5	0	0	1.00	0.10	0.28	0	0	0.65	0.65	1.00	1.00	1.00
6	1.00	0.09	1.00	0.10	0.55	0.70	1.00	0.20	0.90	0.60	1.00	0.84
7	0	0	1.00	0.40	0.35	0	0	0.10	0.10	0	1.00	0
8	0.65	0.02	1.00	0.70	0.59	0.10	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	0.02	1.00	0.40	0.61	0.08	1.00	0.50	0.58	1.00	1.00	1.00
10	0	0	1.00	1.00	0.50	0	0	0	0	1.00	1.00	1.00
			Mean HSI		0.46		Mean HSI		0.62	Mean HSI		0.76
1.56 Acre Seasonal Wetland Vegetation and Riparian Scrub												
1	0.48	0.90	1.00	0.10	0.62	1.00	0.10	0	0.10	0.10	0.07	0.08
2	1.00	0.01	1.00	0.10	0.53	0.05	1.00	0	0.05	0.60	0.07	0.14
3	0.25	0.07	1.00	0.10	0.36	0.53	0	0.58	1.00	0.10	0.07	0.08
4	1.00	0.25	1.00	0.10	0.59	1.00	1.00	1.00	1.00	0.10	0.07	0.08
5	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	0.07	0
6	0	0	1.00	0.10	0.28	0	0	0.30	0.67	0	0.07	0
7	1.00	0.01	1.00	0.10	0.53	0.05	1.00	0.58	1.00	0	0.07	0
8	1.00	0.02	1.00	0.10	0.53	0.10	0	0.58	0.88	0	0.07	0
			Mean HSI		0.52		Mean HSI		0.71	Mean HSI		0.05
0.99 Acre Mature Trees												
1	1.00	0.80	1.00	0.10	0.73	1.00	1.00	0	1.00	1.00	0.06	0.15
2	0.65	0.02	1.00	0.10	0.44	0.03	0	0	0	0.60	0.06	0.13
3	0.62	0.48	1.00	0.10	0.55	1.00	0.60	0	0.60	1.00	0.06	0.15
4	0.80	0.01	1.00	0.10	0.47	0.01	1.00	0.05	0.06	1.00	0.06	0.15
5	1.00	0.68	1.00	0.10	0.69	1.00	1.00	0	1.00	1.00	0.06	0.15
6	1.00	0.01	1.00	0.10	0.53	0.02	1.00	0.90	0.26	0.40	0.06	0.11
7	1.00	1.00	1.00	0.10	0.77	1.00	1.00	0	1.00	1.00	0.06	0.15
8	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0.35	0.38	0.40	0.06	0.11
			Mean HSI		0.59		Mean HSI		0.54	Mean HSI		0.14
0.88 Acre Cottonwoods												
1	0	0	1.00	0.10	0.28	0	0	0.78	0.92	1.00	0.05	0.14
2	0.65	0.01	1.00	0.40	0.52	0.01	0.20	0.50	0.50	1.00	0.05	0.14
3	0	0	1.00	0.10	0.28	0	0	0	0	1.00	0.05	0.14
4	1.00	0.02	1.00	0.40	0.61	0.10	1.00	1.00	1.00	0.10	0.05	0.06
5	0	0	1.00	1.00	0.50	0	0	1.00	1.00	1.00	0.05	0.14
			Mean HSI		0.44		Mean HSI		0.68	Mean HSI		0.12
0.83 Acre Cottonwoods												
1	1.00	0.61	1.00	0.40	0.75	1.00	1.00	0	1.00	0.60	0.05	0.12
2	1.00	0.05	1.00	0.10	0.54	0.40	1.00	0	0.40	0.60	0.05	0.12
3	1.00	0.83	1.00	0.40	0.81	1.00	1.00	0.65	1.00	1.00	0.05	0.14

Non-Impacted Riparian Forest Polygons Under Baseline Conditions Continued.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
4	1.00	0.05	1.00	0.70	0.69	0.40	1.00	1.00	1.00	1.00	0.05	0.14
5	0.85	0.25	1.00	0.40	0.63	1.00	0.30	0.20	0.50	0.60	0.05	0.12
			Mean HSI		0.68		Mean HSI		0.78	Mean HSI		0.13
0.38 Acre Black Locust Grove												
1	0.30	0.05	1.00	0.10	0.36	0.40	0.37	0	0.15	0.60	1.00	0.84
2	0.62	0.48	1.00	0.10	0.55	1.00	0.60	0	0.60	1.00	1.00	1.00
3	1.00	0.25	1.00	0.10	0.66	1.00	1.00	1.00	1.00	0.40	1.00	0.74
			Mean HSI		0.52		Mean HSI		0.58	Mean HSI		0.86

1 HSI = $\frac{V_1 + V_2 + V_3 + V_4}{4}$ 2 HSI = $(V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$, where $V_4 > 50\%$

3 HSI = $(V_6 \times V_7^2)^{1/3}$ 4 HSI = $\frac{V_1 + V_2 + V_3}{3}$ 5 HSI = $(V_1 \times V_2)^{1/2}$

Woodlake Restoration Site, Large Ruderal Area, Existing Baseline Conditions, as Determined from Field Sampling During January 2001.

Sample Plot No.	California Vole SIs			Plot HSI [1]	Owl FV - SIs		Plot HSI [2]	Sample Plot No.	California Vole SIs			Plot HSI [1]	Owl FV - SIs		Plot HSI [2]
	V_1	V_2	V_3		V_1	V_2			V_1	V_2	V_3		V_1	V_2	
1	1.00	1.00	1.00	1.00	1.00	0.40	0.63	31	1.00	0.85	1.00	0.95	1.00	1.00	1.00
2	1.00	0.85	1.00	0.95	1.00	0.80	0.89	32	0.15	0.08	1.00	0.41	0.60	0.20	0.35
3	1.00	0.90	1.00	0.97	1.00	1.00	1.00	33	1.00	0.95	1.00	0.98	1.00	1.00	1.00
4	1.00	0.65	1.00	0.88	1.00	0.80	0.89	34	1.00	0.70	1.00	0.90	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	0.60	0.77	35	1.00	0.70	1.00	0.90	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	36	1.00	0.95	1.00	0.98	1.00	1.00	1.00
7	1.00	0.85	1.00	0.95	1.00	1.00	1.00	37	1.00	0.88	1.00	0.96	1.00	1.00	1.00
8	1.00	0.85	1.00	0.95	1.00	1.00	1.00	38	1.00	0.78	1.00	0.93	1.00	0.80	0.89
9	1.00	0.70	1.00	0.90	1.00	1.00	1.00	39	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	0.78	1.00	0.93	1.00	1.00	1.00	40	1.00	0.95	1.00	0.98	1.00	1.00	1.00
11	1.00	0.65	1.00	0.88	1.00	1.00	1.00	41	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	0.27	1.00	0.76	1.00	1.00	1.00	42	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1.00	0.30	1.00	0.77	1.00	1.00	1.00	43	1.00	0.95	1.00	0.98	1.00	1.00	1.00
14	1.00	0.02	1.00	0.67	0.30	1.00	0.55	44	1.00	0.95	1.00	0.8	1.00	1.00	1.00
15	1.00	0.85	1.00	0.95	1.00	1.00	1.00	45	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1.00	0.85	1.00	0.95	1.00	1.00	1.00	46	1.00	0.85	1.00	0.95	1.00	1.00	1.00
17	1.00	0.80	1.00	0.97	1.00	1.00	1.00	47	1.00	0.95	1.00	0.98	1.00	1.00	1.00
18	1.00	0.85	1.00	0.95	1.00	1.00	1.00	48	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1.00	0.70	1.00	0.90	1.00	1.00	1.00	49	1.00	0.78	1.00	0.93	1.00	1.00	1.00
20	1.00	0.53	1.00	0.84	1.00	1.00	1.00	50	0.65	1.00	1.00	0.88	1.00	0.80	0.89
21	1.00	0.85	1.00	0.95	1.00	1.00	1.00	51	0.85	1.00	1.00	0.95	1.00	0.20	0.45
22	1.00	0.70	1.00	0.90	1.00	1.00	1.00	52	0.65	1.00	1.00	0.88	1.00	1.00	1.00
23	1.00	0.70	1.00	0.90	1.00	1.00	1.00	53	1.00	0.55	1.00	0.85	1.00	1.00	1.00
24	1.00	0.70	1.00	0.90	1.00	1.00	1.00	54	1.00	0.50	1.00	0.83	1.00	1.00	1.00
25	1.00	0.27	1.00	0.76	1.00	1.00	1.00	55	1.00	0.32	1.00	0.7	1.00	0.60	0.77
26	1.00	0.40	1.00	0.80	1.00	1.00	1.00	56	1.00	0.63	1.00	0.88	1.00	0.80	0.89
27	1.00	0.10	1.00	0.70	0.80	1.00	0.89	57	1.00	0.85	1.00	0.95	1.00	0.20	0.45
28	1.00	0.65	1.00	0.88	1.00	1.00	1.00	58	1.00	0.92	1.00	0.97	1.00	1.00	1.00
29	1.00	0.53	1.00	0.84	1.00	1.00	1.00	59	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00	1.00	0.20	0.45	60	1.00	1.00	1.00	1.00	1.00	1.00	1.00
										Mean HSI		0.91	Mean HSI		0.93

[1] $HSI = \frac{V_1 + V_2 + V_3}{3}$

[2] $HSI = (V_1 \times V_2)^{1/2}$

Urrutia Restoration Site, Riparian Forest and Permanent Wetland, Northerly Edge of Site, Existing Baseline Conditions, as Determined from Field Sampling During February 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot	SFCM - Derived SIs							Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]	V_1	V_2	V_3	V_4	V_5	V_6	V_7	HSI [4]
1	0	0	1.00	0.70	0.43	0	0	0.50	0.50	1.00	1.00	1.00	1.00	1.00	0	1.00	1.00	0.20	1.00	0.74
2	0	0	1.00	1.00	0.50	0	0	0.92	0.97	1.00	1.00	1.00	0.30	1.00	0.60	1.00	1.00	0.20	1.00	0.73
3	1.00	0.01	1.00	0.40	0.60	0.06	1.00	0.67	1.00	0	1.00	0	0.30	0	0.30	1.00	1.00	0.20	1.00	0.63
4	0.25	0.01	1.00	0.10	0.34	0.01	0	0.18	0.58	0	1.00	0	0.30	0	0.30	1.00	1.00	0.20	1.00	0.63
5	0	0	1.00	0.10	0.28	0	0	0.30	0.67	1.00	1.00	1.00	0.60	1.00	0.60	1.00	0.30	0.20	1.00	0.70
6	0	0	1.00	0.70	0.43	0	0	0.18	0.57	1.00	1.00	1.00	0.60	1.00	0.60	1.00	1.00	0.20	1.00	0.75
7	0	0	1.00	0.10	0.28	0	0	0.18	0.57	0	1.00	0	0.30	0	0.30	1.00	0.30	0.20	1.00	0.58
8	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0.67	1.00	1.00	1.00	1.00	1.00	0.60	0.60	1.00	1.00	0.20	1.00	0.75
9	0	0	1.00	0.40	0.35	0	0	0.18	0.57	1.00	1.00	1.00	1.00	1.00	0.30	1.00	1.00	0.20	1.00	0.76
10	1.00	0.09	1.00	0.10	0.55	0.70	1.00	0.50	1.00	0	1.00	0	0.60	0	0.60	1.00	0.30	0.20	1.00	0.62
11	0	0	1.00	0.40	0.35	0	0	0.65	0.65	1.00	1.00	1.00	0.60	1.00	0.60	1.00	1.00	0.20	1.00	0.75
12	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0.10	1.00	0	1.00	0	0.30	0	0.30	1.00	1.00	0.20	1.00	0.63
13	1.00	0.25	1.00	0.10	0.59	1.00	1.00	0.20	1.00	0.40	1.00	0.74	0.30	1.00	0.60	1.00	0.30	0.20	1.00	0.68
14	0	0	1.00	1.00	0.50	0	0	0.50	0.79	0.60	1.00	0.84	0.60	0.60	0.60	1.00	1.00	0.20	1.00	0.72
15	0.18	0.04	1.00	0.40	0.41	0.30	0	0.40	0.89	0.60	1.00	0.84	1.00	1.00	0.60	1.00	0.30	0.20	1.00	0.73
16	1.00	0.08	1.00	0.10	0.55	0.57	1.00	0.18	0.75	0	1.00	0	0.30	0	0.30	1.00	1.00	0.20	1.00	0.63
17	0.25	0.03	1.00	0.40	0.42	0.20	0	0.18	0.72	0	1.00	0	0.60	0	0.60	1.00	0.30	0.20	1.00	0.62
18	0	0	1.00	0.40	0.35	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.30	1.00	1.00	0.20	1.00	0.76
19	0	0	1.00	0.40	0.35	0	0	0.83	0.94	0.60	1.00	0.84	0.60	0.60	0.60	1.00	0	0.20	1.00	0.65
20	1.00	0.02	1.00	1.00	0.76	0.08	1.00	0.08	0.16	0.60	1.00	0.84	0.60	0.60	0	1.00	1.00	0.20	1.00	0.68
21	1.00	0.02	1.00	0.10	0.53	0.08	1.00	1.00	1.00	1.00	1.00	1.00	0.60	1.00	0.60	1.00	1.00	0.20	1.00	0.75
22	0	0	1.00	0.40	0.35	0	0	0	0	1.00	1.00	1.00	0.60	0.60	0.30	1.00	1.00	0.20	1.00	0.70
23	1.00	0.04	1.00	0.40	0.61	0.30	1.00	0	0.30	0.10	1.00	0.46	0.30	0.60	0.60	1.00	0.30	0.20	1.00	0.65
24	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0.08	0.11	0.60	1.00	0.84	0.60	1.00	0	1.00	1.00	0.20	1.00	0.71
25	1.00	0.02	1.00	0.10	0.53	0.06	1.00	0.83	1.00	0.40	1.00	0.74	1.00	0.60	0.30	1.00	0.30	0.20	1.00	0.68
26	1.00	0.10	1.00	0.40	0.63	0.78	1.00	0.83	1.00	1.00	1.00	1.00	0.60	1.00	0.30	1.00	1.00	0.20	1.00	0.73

Riparian Forest and Permanent Wetland Continued.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot	SFCM - Derived SIs							Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]	V_1	V_2	V_3	V_4	V_5	V_6	V_7	HSI [4]
27	1.00	0.10	1.00	0.10	0.55	0.78	1.00	0	0.78	0.10	1.00	0.46	0.30	1.00	0.30	1.00	0.30	0.20	1.00	0.65
28	1.00	0.04	1.00	0.10	0.54	0.30	1.00	0.26	1.00	0	1.00	0	0.30	0	0	1.00	0.30	0.20	1.00	0.55
29	1.00	0.09	1.00	0.40	0.62	0.70	0.20	0	0.14	0	1.00	0	0	0	0.30	1.00	1.00	0.20	1.00	0.61
30	0	0	1.00	0.10	0.28	0	0	0.50	0.50	0.10	1.00	0.46	0.60	1.00	0.30	1.00	1.00	0.20	1.00	0.73
31	0.65	0.02	1.00	0.70	0.59	0.16	0.20	0.50	0.53	1.00	1.00	1.00	0.60	1.00	0	1.00	1.00	0.20	1.00	0.71
32	0	0	1.00	0.70	0.43	0	0	0.50	0.50	1.00	1.00	1.00	1.00	1.00	0.60	1.00	0.30	0.20	1.00	0.73
33	0.48	0.02	1.00	0.70	0.55	0.06	0.10	0.18	0.70	0.60	1.00	0.84	0.60	0.60	0.60	1.00	1.00	0.20	1.00	0.72
34	0.65	0.03	1.00	1.00	0.67	0.18	0	1.00	1.00	1.00	1.00	1.00	0.60	0.60	0.60	1.00	1.00	0.20	1.00	0.72
35	0	0	1.00	0.70	0.43	0	0	0.18	0.57	0	1.00	0	0.30	0	0.30	1.00	1.00	0.20	1.00	0.63
36	0	0	1.00	0.70	0.43	0	0	0.18	0.57	1.00	1.00	1.00	1.00	0.30	0.60	1.00	1.00	0.20	1.00	0.73
37	0	0	1.00	0.40	0.35	0	0	0.18	0.57	1.00	1.00	1.00	0.60	0.60	0.60	1.00	1.00	0.20	1.00	0.72
38	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0.20	1.00	1.00	1.00	1.00	0.60	1.00	0.30	1.00	0.30	0.20	1.00	0.68
39	1.00	0.03	1.00	0.10	0.53	0.18	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.30	0.30	1.00	1.00	0.20	1.00	0.68
40	0	0	1.00	0.40	0.35	0	0	0.83	0.94	0.60	1.00	0.84	0.60	0.30	0.60	1.00	0.30	0.20	1.00	0.65
41	1.00	0.09	1.00	0.10	0.55	0.60	1.00	0.40	1.00	1.00	1.00	1.00	0.60	0.60	0.60	1.00	1.00	0.20	1.00	0.72
42	0	0	1.00	0.70	0.43	0	0	0.18	0.57	0.10	1.00	0.46	0.60	0.30	0.60	1.00	0.30	0.20	1.00	0.65
43	1.00	0.02	1.00	0.10	0.53	0.13	1.00	0.65	0.78	1.00	1.00	1.00	0.60	0.60	0.30	1.00	1.00	0.20	1.00	0.70
44	1.00	0.01	1.00	0.10	0.53	0.08	1.00	0.65	0.73	0.40	1.00	0.74	0.60	0.60	0.30	1.00	0.30	0.20	1.00	0.65
45	1.00	0.02	1.00	0.70	0.68	0.10	1.00	0.40	1.00	0	1.00	0	0.30	0	0.30	1.00	1.00	0.20	1.00	0.63
46	1.00	0.02	1.00	0.10	0.53	0.10	1.00	1.00	1.00	0	1.00	0	0.60	0	0.60	1.00	0	0.20	1.00	0.60
47	0	0	1.00	0.40	0.35	0	0	0.30	0.67	0	1.00	0	0.60	0	0.30	1.00	0.30	0.20	1.00	0.60
48	1.00	0.47	1.00	0.10	0.64	1.00	1.00	0	1.00	0.10	1.00	0.46	0.30	0.60	0.30	1.00	0.30	0.20	1.00	0.62
			Mean HSI		0.50	Mean HSI			0.74	Mean HSI		0.63							Mean HSI	0.68

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$ [2] $HSI = (V_1 \times V_2) + V_4$ (not to exceed 1.0), where V4 <50%; $(V_1 + V_2 + V_4)^{1/3}$, where V4 >50%

[3] $HSI = (V_6 \text{ X } V_7^2)^{1/3}$ [4] $HSI = \frac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$

Urrutia Restoration Site, Existing Baseline Conditions for Young Cottonwoods/Seasonal Floodplain Habitat within the Grassland Habitat of the Northeast Portion of the Site, as Determined from Field Sampling and Hydrologic Analyses During February 2001.

Sample Plot No.	California Vole SIs				Plot HSI [1]	Owl FV SIs			Plot HSI [2]	Owl CRV SIs		Plot HSI [3]	SFCM - Derived SIs							Plot HSI [4]
	V_1	V_2	V_3	V_4		V_1	V_2	V_4		V_6	V_7		V_1	V_2	V_3	V_4	V_5	V_6	V_7	
1	1.00	0.83	1.00	0.10	0.73	1.00	1.00	0	1.00	0.10	0.07	0.08	0.30	0	0.30	1.00	1.00	0.20	0.20	0.32
2	1.00	0.75	1.00	0.10	0.71	1.00	0.61	0	0.61	0	0.07	0	0	0	0.30	1.00	1.00	0.20	0.20	0.30
3	1.00	0.75	1.00	0.10	0.71	1.00	1.00	0	1.00	0.10	0.07	0.08	0.30	0	0.30	1.00	1.00	0.20	0.20	0.32
4	1.00	0.54	1.00	0.10	0.66	1.00	0.20	0	0.20	0.10	0.07	0.08	0.30	0	0.30	1.00	1.00	0.20	0.20	0.32
5	1.00	0.40	1.00	0.40	0.70	1.00	0.20	0	0.20	0.10	0.07	0.08	0.30	0	0.60	1.00	1.00	0.20	0.20	0.35
6	1.00	0.25	1.00	0.10	0.59	1.00	0	0	0	0.10	0.07	0.08	0.30	0	0.60	1.00	1.00	0.20	0.20	0.35
7	1.00	0.09	1.00	0.10	0.55	0.70	0.45	1.00	1.00	0.10	0.07	0.08	0.30	0	0.30	1.00	0.30	0.20	0.20	0.27
8	1.00	0.70	1.00	0.10	0.70	1.00	0.91	0	0.91	0	0.07	0	0	0	0.30	1.00	0.30	0.20	0.20	0.25
9	1.00	0.25	1.00	0.10	0.59	1.00	1.00	0	1.00	0.10	0.07	0.08	0.30	0	0.60	1.00	1.00	0.20	0.20	0.35
10	0.25	0.01	1.00	0.10	0.34	0.03	0	0	0	0	0.07	0	0	0	0	1.00	0.30	0.20	0.20	0.22
11	1.00	0.02	1.00	0.10	0.53	0.10	1.00	0	0.10	0.10	0.07	0.08	0.30	0	0.60	1.00	1.00	0.20	0.20	0.35
12	1.00	0.02	1.00	0.10	0.53	0.08	1.00	0	0.08	0.10	0.07	0.08	0.30	0	0.60	1.00	1.00	0.20	0.20	0.35
13	0.48	0.01	1.00	0.10	0.40	0.01	1.00	0	0.01	0.10	0.07	0.08	0.30	0.60	0.60	1.00	0.30	0.20	0.20	0.22
14	1.00	0.01	1.00	0.10	0.53	0.03	1.00	0	0.03	0.10	0.07	0.08	0.30	0	0.60	1.00	0.30	0.20	0.20	0.17
15	1.00	0.75	1.00	0.10	0.71	1.00	0.10	0	0.10	0	0.07	0	0	0	0.30	1.00	1.00	0.20	0.20	0.30
16	1.00	0.10	1.00	0.10	0.55	0.78	0.10	0	0.08	0.10	0.07	0.08	0.30	0	0.60	1.00	1.00	0.20	0.20	0.35
17	1.00	0.40	1.00	0.10	0.63	1.00	0.10	0	0.10	0.10	0.07	0.08	0.30	0	0.60	1.00	0.30	0.20	0.20	0.30
18	1.00	0.09	1.00	0.10	0.55	0.70	0	0	0	0.10	0.07	0.08	0.30	0	0.30	1.00	0.30	0.20	0.20	0.27
			Mean HSI		0.60	Mean HSI			0.36	Mean HSI		0.06						Mean HSI		0.30

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$

[3] $HSI = (V_6 \times V_7^2)^{1/3}$

[4] $HSI = \frac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$

Urrutia Restoration Site, Existing Baseline Conditions for Seasonal Floodplain Habitat within the Oak Cottonwood Forest, as Determined from Field Sampling and Hydrologic Analyses During February 2001.

Sample Plot No.	California Vole SIs				Plot HSI [1]	Owl FV SIs			Plot HSI [2]	Owl CRV SIs		Plot HSI [3]	SFCM - Derived SIs							Plot HSI [4]
	V_1	V_2	V_3	V_4		V_1	V_2	V_4		V_6	V_7		V_1	V_2	V_3	V_4	V_5	V_6	V_7	
1	0	0	1.00	0.70	0.43	0	0	0.50	0.50	0.10	1.00	0.46	0.60	1.00	0.30	1.00	1.00	0.20	0.20	0.42
2	0	0	1.00	0	0.25	0	0	0	0	0.10	1.00	0.46	0.30	0.60	0.30	1.00	1.00	0.20	0.20	0.37
3	0.48	0	1.00	0	0.37	0	0	0.18	0.57	0	1.00	0	0.30	0	0.30	1.00	0.30	0.20	0.20	0.27
4	0.25	0.02	1.00	0.10	0.34	0.10	0.91	0	0.09	0	1.00	0	0	0	0.60	1.00	1.00	0.20	0.20	0.32
5	1.00	0.01	1.00	0.40	0.60	0.01	0	0	0	0	1.00	0	0	0	1.00	1.00	1.00	0.20	0.20	0.35
6	1.00	0.04	1.00	0.10	0.54	0.30	1.00	0	0.30	0.10	1.00	0.46	0.30	1.00	1.00	0.30	1.00	0.20	0.20	0.40
7	1.00	0.05	1.00	0.10	0.54	0.40	1.00	0	0.40	0.40	1.00	0.74	0.30	1.00	1.00	0.30	1.00	0.20	0.20	0.40
8	1.00	0.30	1.00	0.10	0.60	1.00	1.00	0	1.00	0.10	1.00	0.46	0.30	0.60	1.00	0.60	1.00	0.20	0.20	0.39
9	1.00	0.47	1.00	0.70	0.79	1.00	0.20	0	0.20	0.10	1.00	0.46	0.30	1.00	1.00	0.60	1.00	0.20	0.20	0.42
10	1.00	0.17	1.00	0.40	0.64	0.86	1.00	0.65	1.00	0.10	1.00	0.46	0.30	0.60	1.00	0.60	1.00	0.20	0.20	0.39
11	1.00	0.54	1.00	0.40	0.74	1.00	1.00	1.00	1.00	0.10	1.00	0.46	0.30	1.00	1.00	0.60	1.00	0.20	0.20	0.42
12	1.00	0.40	1.00	0.40	0.70	1.00	0	0	0	0	1.00	0	0	0	1.00	0.30	1.00	0.20	0.20	0.30
13	1.00	0.80	1.00	0.10	0.73	1.00	1.00	0	1.00	0	1.00	0	0	0	1.00	0.60	1.00	0.20	0.20	0.32
14	1.00	0.09	1.00	0.10	0.55	0.70	0	0	0	0	1.00	0	0	0	1.00	0.30	1.00	0.20	0.20	0.30
15	1.00	0.05	1.00	0.40	0.61	0.40	1.00	0	0.40	0.10	1.00	0.46	0.30	0.30	1.00	0.60	1.00	0.20	0.20	0.37
16	1.00	0.04	1.00	0.10	0.54	0.30	0.05	0	0.02	0	1.00	0	0	0	1.00	0.30	1.00	0.20	0.20	0.32
			Mean HSI		0.56	Mean HSI			0.41	Mean HSI		0.28							Mean HSI	0.36

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \text{ x } V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$

[3] $HSI = (V_6 \text{ X } V_7^2)^{1/3}$

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[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \text{ x } V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$

[3] $HSI = (V_6 \text{ X } V_7^2)^{1/3}$

[4] $HSI = \frac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$

[4] $$HSI = \frac{\Sigma (V_1 - V_5) + 3V_6 + 5V_7}{13}$$

Urrutia Restoration Site, Baseline Conditions for the SRA Cover along the American River, as Determined from Application of the Service's SRA Habitat Suitability Index Model as Applied Through Visual Assessment of 35 mm Photography of the Nearshore Area.

SI Number	Photograph Number						Mean HSI=
	6	7	8	9	10	12	
1	0.20	0.20	0.05	0	0.10	0	
2	0.20	0.20	0.40	0.35	0.10	0.15	
3	0.90	0.90	0.90	0.90	0.90	0.90	
4	1.00	1.00	1.00	1.00	1.00	1.00	
5	1.00	0.20	0.20	1.00	0.20	0.20	
6	0.20	0.30	0.30	0.20	0.40	0.20	
HSI=	0.33	0.21	0.22	0.31	0.16	0.11	0.22

Interpreted (visually from the photographs and from observations when the photographs were acquired) *width* of the SRA Cover along the site: 15 feet.

Urrutia Restoration Site, Baseline Conditions for the Oak Cottonwood Forest of the Northeast Portion of the Site, as Determined from Field Sampling During February 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
1	1.00	0.09	1.00	0.10	0.55	0.70	1.00	0	0.70	0.60	1.00	0.84
2	1.00	0.03	1.00	0.70	0.68	0.20	1.00	0	0.20	0.60	1.00	0.84
3	1.00	0.02	1.00	0.10	0.53	0.10	1.00	0	0.10	1.00	1.00	1.00
4	1.00	0.02	1.00	0.40	0.61	0.06	1.00	0.65	0.71	1.00	1.00	1.00
5	1.00	0.08	1.00	0.40	0.62	0.57	1.00	0	0.57	1.00	1.00	1.00
6	1.00	0.01	1.00	0.10	0.53	0.01	1.00	0	0.01	0.10	1.00	0.47
7	1.00	0.01	1.00	0.70	0.68	0.01	1.00	0	0.01	1.00	1.00	1.00
8	0	0	1.00	0.10	0.28	0	0	0	0	0	1.00	0
9	0	0	1.00	0.40	0.35	0	0	0.50	0.79	0.60	1.00	0.84
10	0	0	1.00	0.40	0.35	0	0	0.83	0.94	0	1.00	0
11	1.00	0.03	1.00	0.70	0.68	0.20	1.00	1.00	1.00	1.00	1.00	1.00
12	0	0	1.00	0.10	0.28	0	0	0	0	0.10	1.00	0.47
13	0	0	1.00	0.10	0.28	0	0	1.00	1.00	0.10	1.00	0.47
14	1.00	0.54	1.00	0.40	0.74	1.00	0.10	0	0.10	0	1.00	0
15	1.00	0.10	1.00	0.10	0.55	0.78	1.00	0	0.78	0.10	1.00	0.47
16	1.00	0.83	1.00	0.40	0.81	1.00	0.91	0	0.91	0	1.00	0
17	1.00	0.03	1.00	0.70	0.68	0.18	0.87	0.21	1.00	0	1.00	0
			Mean HSI		0.54		Mean HSI		0.52	Mean HSI		0.55

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] HSI = $(V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$, where $V_4 > 50\%$

[3] HSI = $(V_6 \times V_7^2)^{1/3}$

Urrutia Restoration Site, Large Ruderal Area of Northeast Portion of the Site, Existing Baseline Conditions, as Determined from Field Sampling During February 2001.

Sample Plot No.	California Vole SIs			Plot HSI [1]	Owl FV - SIs		Plot HSI [2]	Sample Plot No.	California Vole SIs			Plot HSI [1]	Owl FV - SIs		Plot HSI [2]
	V_1	V_2	V_3		V_1	V_2			V_1	V_2	V_3		V_1	V_2	
1	1.00	0.70	1.00	0.90	1.00	1.00	1.00	28*	1.00	0.61	1.00	0.87	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	29	1.00	0.83	1.00	0.94	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	30	1.00	1.00	1.00	1.00	1.00	0.78	0.88
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	31	1.00	0.83	1.00	0.94	1.00	0.61	0.78
5	1.00	0.83	1.00	0.94	1.00	0.87	0.93	32	1.00	0.75	1.00	0.92	1.00	1.00	1.00
6	1.00	0.75	1.00	0.92	1.00	1.00	1.00	33	1.00	0.90	1.00	0.97	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	34	1.00	0.70	1.00	0.90	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	0.40	1.00	0.63	35	1.00	0.54	1.00	0.85	1.00	0.78	0.88
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	36	0.65	1.00	1.00	0.88	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	37	0.48	1.00	1.00	0.83	1.00	0.05	0.22
11	1.00	0.83	1.00	0.71	1.00	0.61	0.78	38	0.65	1.00	1.00	0.88	1.00	0.06	0.25
12	1.00	0.90	1.00	0.97	1.00	1.00	1.00	39	1.00	0.95	1.00	0.98	1.00	0.10	0.32
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	40	1.00	0.54	1.00	0.85	1.00	0.53	0.73
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	41	1.00	0.75	1.00	0.92	1.00	1.00	1.00
15	0.65	1.00	1.00	0.88	1.00	0.20	0.45	42	1.00	0.87	1.00	0.96	1.00	1.00	1.00
16	1.00	0.90	1.00	0.97	1.00	1.00	1.00	43	1.00	0.95	1.00	0.98	1.00	0.61	0.78
17	1.00	0.90	1.00	0.97	1.00	1.00	1.00	44	1.00	0.75	1.00	0.92	1.00	0.87	0.93
18	1.00	0.83	1.00	0.71	1.00	0.20	0.45	45	1.00	0.70	1.00	0.90	1.00	1.00	1.00
19	1.00	0.75	1.00	0.92	1.00	1.00	1.00	46	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	0.40	1.00	0.80	1.00	0.78	0.88	47	1.00	0.83	1.00	0.94	1.00	1.00	1.00
21	1.00	0.90	1.00	0.97	1.00	1.00	1.00	48	1.00	0.92	1.00	0.97	1.00	1.00	1.00
22	1.00	0.90	1.00	0.97	1.00	1.00	1.00	49	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	0.83	1.00	0.71	1.00	1.00	1.00	50	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24	1.00	0.75	1.00	0.92	1.00	1.00	1.00	51	1.00	0.95	1.00	0.98	1.00	1.00	1.00
25	1.00	0.61	1.00	0.87	1.00	1.00	1.00	52	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26	1.00	0.47	1.00	0.82	1.00	1.00	1.00	53	1.00	0.90	1.00	0.97	1.00	1.00	1.00
27	1.00	0.08	1.00	0.69	0.57	1.00	0.76	54	1.00	0.90	1.00	0.97	1.00	1.00	1.00
										Mean HSI		0.93	Mean HSI		0.90

[1] $HSI = \frac{V_1 + V_2 + V_3}{3}$

[2] $HSI = (V_1 \times V_2)^{1/2}$

Bushy Lake Restoration Site, Baseline Conditions for the Riparian area, Slope Portion as Determined from Field Sampling During March 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
1	1.00	0.02	1.00	0.10	0.53	0.15	1.00	0	0.15	0.60	1.00	0.84
2	1.00	0.54	1.00	0.10	0.66	1.00	1.00	1.00	1.00	0	1.00	0
3	0.65	1.00	1.00	0.10	0.69	1.00	0	0	0	0	1.00	0
4	0.85	1.00	1.00	0.10	0.74	1.00	0.87	1.00	1.00	0.10	1.00	0.46
5	0.25	0.30	1.00	0.10	0.41	1.00	0	0	0	0	1.00	0
6	1.00	0.17	1.00	0.10	0.57	0.86	1.00	0	0.86	0	1.00	0
7	1.00	0.03	1.00	0.10	0.53	0.20	1.00	0.30	1.00	0.40	1.00	0.74
8	1.00	0.83	1.00	0.10	0.73	1.00	1.00	0	1.00	0.10	1.00	0.46
9	0	0	1.00	0.10	0.28	0	0	0.18	0.57	0.10	1.00	0.46
10	1.00	0.04	1.00	0.40	0.61	0.30	1.00	0	0.30	0.60	1.00	0.84
11	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0.10	1.00	0.46
12	1.00	0.70	1.00	0.10	0.70	1.00	1.00	0	1.00	0	1.00	0
13	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0.40	1.00	0.74
14	1.00	0.08	1.00	0.40	0.62	0.61	1.00	0.10	0.71	0	1.00	0
15	1.00	0.01	1.00	1.00	0.75	0.03	1.00	0	0.03	0.10	1.00	0.46
16	1.00	0.03	1.00	0.40	0.61	0.20	1.00	0.83	1.00	0.40	1.00	0.74
17	0.85	0.54	1.00	0.10	0.62	1.00	1.00	0	1.00	0	1.00	0
18	1.00	0.25	1.00	0.10	0.59	1.00	1.00	0	1.00	0	1.00	0
19	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0	1.00	0	1.00	0
20	1.00	0.61	1.00	0.10	0.68	1.00	1.00	0	1.00	0	1.00	0
21	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0.30	1.00	0.60	1.00	0.84
22	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0	1.00	0	1.00	0
23	1.00	0.61	1.00	0.10	0.68	1.00	1.00	0	1.00	0.40	1.00	0.74
24	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	1.00	0
25	1.00	0.04	1.00	0.10	0.54	0.30	1.00	0.65	0.95	0.10	1.00	0.46
26	1.00	0.47	1.00	0.70	0.79	1.00	1.00	0	1.00	0.60	1.00	0.84
27	1.00	0.30	1.00	0.10	0.60	1.00	0.05	0	0.05	0	1.00	0
28	0.65	0.47	1.00	0.10	0.56	1.00	1.00	0	1.00	0	1.00	0
29	1.00	0.95	1.00	0.10	0.76	1.00	1.00	0	1.00	0.10	1.00	0.46
30	1.00	0.95	1.00	0.10	0.76	1.00	1.00	0	1.00	0	1.00	0
31	1.00	0.70	1.00	0.40	0.78	1.00	1.00	0	1.00	0.10	1.00	0.46
32	1.00	0.05	1.00	0.40	0.61	0.45	1.00	0.10	0.55	0.10	1.00	0.46
33	0.65	0.83	1.00	0.10	0.65	1.00	1.00	0	1.00	1.00	1.00	1.00
34	0.65	0.04	1.00	0.10	0.45	0.30	0.10	0	0.03	0	1.00	0
35	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0	1.00	0
			Mean HSI		0.65		Mean HSI		0.78	Mean HSI		0.33

[1] HSI = $\frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] HSI = $(V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$, where $V_4 > 50\%$

[3] HSI = $(V_6 \times V_7^2)^{1/3}$

Bushy Lake Restoration Site, Baseline Conditions for the Riparian area, Upper Flat Portion as Determined from Field Sampling During March 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
1	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	1.00	1.00	1.00
2	1.00	0.47	1.00	0.10	0.64	1.00	1.00	0	1.00	0	1.00	0
3	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0	1.00	1.00	1.00	1.00
4	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	1.00	0
5	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0.10	1.00	0.46
6	1.00	0.96	1.00	0.10	0.77	1.00	0	0	0	0	1.00	0
7	1.00	0.10	1.00	0.10	0.55	0.78	1.00	0.83	1.00	0	1.00	0
8	1.00	0.40	1.00	0.10	0.63	1.00	1.00	1.00	1.00	0	1.00	0
9	1.00	0.40	1.00	0.10	0.63	1.00	1.00	0	1.00	0	1.00	0
10	1.00	0.90	1.00	0.10	0.75	1.00	1.00	1.00	1.00	0	1.00	0
11	0.85	1.00	1.00	0.10	0.74	1.00	1.00	0.83	1.00	0	1.00	0
12	1.00	0.01	1.00	0.40	0.60	0.03	1.00	0.50	1.00	0.20	1.00	0.59
13	0.48	0.70	1.00	0.10	0.57	1.00	0	0	0	0	1.00	0
14	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0.50	1.00	0	1.00	0
15	0.65	0.02	1.00	0.10	0.44	0.08	1.00	0	0.08	0	1.00	0
16	0.48	1.00	1.00	0.10	0.65	1.00	0	0	0	0.20	1.00	0.59
17	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0	1.00	0
18	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0	1.00	0
19	0.25	0.40	1.00	0.10	0.44	1.00	0	0	0	0	1.00	0
20	1.00	0.83	1.00	0.10	0.73	1.00	1.00	0	1.00	0	1.00	0
21	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0	1.00	0	1.00	0
22	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	1.00	1.00	1.00
23	1.00	0.40	1.00	0.10	0.63	1.00	1.00	1.00	1.00	0.10	1.00	0.46
24	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0.60	1.00	0.84
25	1.00	0.47	1.00	0.40	0.72	1.00	1.00	0	1.00	0	1.00	0
26	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	1.00	0
27	1.00	0.95	1.00	0.10	0.76	1.00	1.00	0	1.00	0.40	1.00	0.74
28	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	1.00	0
29	1.00	0.75	1.00	0.10	0.71	1.00	1.00	0	1.00	0	1.00	0
30	1.00	0.54	1.00	0.10	0.66	1.00	1.00	0	1.00	0.40	1.00	0.74
31	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0	1.00	0	1.00	0
32	1.00	0.61	1.00	0.10	0.68	1.00	1.00	0	1.00	0.10	1.00	0.46
33	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	1.00	0
34	1.00	0.75	1.00	0.10	0.71	1.00	1.00	0	1.00	0.10	1.00	0.46
35	0.65	0.88	1.00	0.10	0.66	1.00	0.20	0	0.20	0	1.00	0
36	1.00	0.90	1.00	0.10	0.75	1.00	1.00	0	1.00	0	1.00	0
			Mean HSI		0.69		Mean HSI		0.84	Mean HSI		0.23

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$ [2] $HSI = (V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$, where $V_4 > 50\%$ [3] $HSI = (V_6 \times V_7^2)^{1/3}$

Bushy Lake Restoration Site, Riparian Forest Floodplain, Existing Baseline Conditions, as Determined from Field Sampling During March 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot	SFCM - Derived SIs							Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]	V_1	V_2	V_3	V_4	V_5	V_6	V_7	HSI [4]
1	1.00	0.40	1.00	0.40	0.70	1.00	1.00	0	1.00	0	1.00	0	0.30	0.30	0	1.00	0.30	0.20	0.20	0.27
2	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0	0	0.30	0	1.00	0	0.20	0.20	0.22
3	1.00	1.00	1.00	0.70	0.93	1.00	1.00	1.00	1.00	0.10	1.00	0.46	0	0.30	0	1.00	0	0.20	0.20	0.22
4	1.00	0.25	1.00	0.10	0.59	1.00	1.00	0.58	1.00	0.10	1.00	0.46	0.30	0.30	0	1.00	0.30	0.20	0.20	0.27
5	1.00	0.70	1.00	0.70	0.85	1.00	1.00	0.18	1.00	0.40	1.00	0.74	0	0	0.30	1.00	1.00	0.20	0.20	0.30
6	0.48	0.25	1.00	0.40	0.53	1.00	0	1.00	1.00	0.10	1.00	0.46	0.30	0.60	0.30	1.00	0.30	0.20	0.20	0.32
7	0.85	0.54	1.00	0.70	0.77	1.00	0	1.00	1.00	0.10	1.00	0.46	0.30	1.00	0.30	1.00	1.00	0.20	0.20	0.40
8	0.25	0.10	1.00	0.10	0.36	0.78	0	0.20	0.20	0	1.00	0	0.60	1.00	0.60	1.00	1.00	0.20	0.20	0.45
9	1.00	0.70	1.00	0.10	0.70	1.00	1.00	0.18	1.00	0.60	1.00	0.84	0	0	0	1.00	0.30	0.20	0.20	0.22
10	1.00	0.25	1.00	0.10	0.59	1.00	0.53	0.18	1.00	0.60	1.00	0.84	0.30	0.30	0	1.00	0	0.20	0.20	0.25
11	0	0	1.00	0.10	0.28	0	0	0.18	0.57	0.60	1.00	0.84	0.30	0.60	0.60	1.00	0	0.20	0.20	0.32
12	0.65	0.70	1.00	0.70	0.76	1.00	0	0.18	1.00	0.10	1.00	0.46	0.60	1.00	0.30	1.00	0.30	0.20	0.20	0.37
13	1.00	0.83	1.00	0.04	0.72	1.00	1.00	1.00	1.00	0.10	1.00	0.46	0.30	1.00	0.60	1.00	0.30	0.20	0.20	0.37
14	1.00	0.54	1.00	0.70	0.81	1.00	1.00	0.67	1.00	0.10	1.00	0.46	0.30	1.00	0.60	1.00	0	0.20	0.20	0.35
15	0.65	0.83	1.00	0.70	0.80	1.00	0	1.00	1.00	0.40	1.00	0.74	0.60	1.00	0.60	1.00	1.00	0.20	0.20	0.45
16	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.58	1.00	0.10	1.00	0.46	0	0.30	0.30	1.00	0.30	0.20	0.20	0.27
17	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0.50	1.00	0.60	1.00	0.84	0.30	1.00	0.60	1.00	0.30	0.20	0.20	0.37
18	1.00	0.70	1.00	0.10	0.70	1.00	1.00	0.18	1.00	0.40	1.00	0.74	0.30	0.60	1.00	1.00	0.30	0.20	0.20	0.37
19	1.00	0.10	1.00	0.70	0.70	0.78	0.87	0.18	1.00	0.40	1.00	0.74	0.30	1.00	1.00	1.00	0.30	0.20	0.20	0.40
20	1.00	0.70	1.00	0.70	0.85	1.00	1.00	0.58	1.00	0.10	1.00	0.46	0.60	1.00	0.60	1.00	1.00	0.20	0.20	0.45
21	1.00	0.83	1.00	0.70	0.88	1.00	1.00	0.58	1.00	0.40	1.00	0.74	0.60	1.00	1.00	1.00	1.00	0.20	0.20	0.48
22	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.18	1.00	0.40	1.00	0.74	0.30	0.60	0	1.00	0	0.20	0.20	0.27
23	1.00	0.61	1.00	0.70	0.83	1.00	1.00	1.00	1.00	0.40	1.00	0.74	0.30	0.30	0	1.00	0	0.20	0.20	0.25
24	1.00	0.70	1.00	0.70	0.85	1.00	1.00	0.18	1.00	0.10	1.00	0.46	0.30	0.30	0.60	1.00	0	0.20	0.20	0.29
25	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0.18	1.00	0.40	1.00	0.74	0.30	1.00	1.00	1.00	0	0.20	0.20	0.38
26	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0.18	1.00	0.40	1.00	0.74	0.60	1.00	1.00	1.00	0.30	0.20	0.20	0.42
27	1.00	0.83	1.00	0.70	0.88	1.00	1.00	0.58	1.00	0.10	1.00	0.46	0.30	1.00	0.30	1.00	0.30	0.20	0.20	0.35
28	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0	1.00	0	1.00	0	0.30	1.00	1.00	1.00	1.00	0.20	0.20	0.45
29	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0	1.00	0	1.00	0	0.30	1.00	0.60	1.00	1.00	0.20	0.20	0.42
30	1.00	0.83	1.00	0.10	0.73	1.00	1.00	1.00	1.00	0.10	1.00	0.46	0.30	0.60	0.30	1.00	0	0.20	0.20	0.29
			Mean HSI		0.75	Mean HSI			0.96	Mean HSI		0.52							Mean HSI	0.34

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \times V_2) + V_4$ (not to exceed 1.0), where V4 <50%; $(V_1 + V_2 + V_4)^{1/3}$, where V4 >50

[3] $HSI = (V_6 \times V_7^{2})^{1/3}$

[4] $HSI = \frac{\Sigma(V_1 - V_5) + 3V_6 + 5V_7}{13}$

Bushy Lake Restoration Site, SRA Cover, Existing Baseline Conditions, as Determined from Field Sampling During March 2001.

Transect	V1 Overhead Cover	V2 Instream Cover Area	V3 Instream Cover Composition	V4 Instream/Overhead Interaction	V5 Substrate Composition	V6 Water Depth	HSI[1]
1	1.00	0	0.10	0.50	0.50	1.00	0.42
2	0.09	1.00	0.73	1.00	1.00	0.70	0.56
3	0.40	1.00	0.91	1.00	1.00	0.50	0.69
4	0.02	1.00	1.00	1.00	1.00	0.90	0.66
5	0	0	0	0	1.00	1.00	0.33
6	0.01	0	0	0	1.00	1.00	0.33
7	1.00	1.00	0.90	1.00	1.00	0.80	0.93
8	0.95	1.00	0.90	1.00	1.00	0.90	0.93
9	0.65	0	0	0.50	1.00	1.00	0.44
10	1.00	1.00	0.90	1.00	1.00	1.00	0.97
11	1.00	1.00	0.90	1.00	1.00	0.80	0.93
12	1.00	1.00	0.90	1.00	0.50	1.00	0.88
13	0.95	0	0	0.50	0.50	1.00	0.41
14	0.65	0	0	0.50	0.50	1.00	0.36
15	0	0	0	0	0.50	1.00	0.25
16	0.40	1.00	0.90	1.00	1.00	1.00	0.77
17	1.00	1.00	0.90	1.00	0.50	0.70	0.83
18	1.00	1.00	0.90	1.00	1.00	0.80	0.93
19	0	0	0	0	1.00	1.00	0.33
20	0	0	0.10	0	0.50	1.00	0.25
21	0	0	0.10	0	0.50	1.00	0.25
22	0.28	0	0.10	0	0.50	1.00	0.25
23	0.80	0	0.10	0.50	1.00	1.00	0.47
24	0.40	0	0.10	0.50	0.50	1.00	0.32
25	0.40	0	0.10	0.50	0.50	1.00	0.32
26	1.00	0	0.10	0.50	0.50	1.00	0.42
27	0.90	1.00	0.90	1.00	1.00	1.00	0.93
28	0.40	0.30	0.90	1.00	1.00	1.00	0.56
29	0.60	1.00	0.90	1.00	1.00	1.00	0.83
30	0	0	0	0	1.00	1.00	0.33
31	0	0	0	0	1.00	1.00	0.33
32	0.18	1.00	0	1.00	1.00	1.00	0.39
33	0.10	0	0.10	0.50	1.00	0.50	0.27
34	0.05	0	0.10	0.50	1.00	0.50	0.26
35	0	0	0	0	1.00	1.00	0.33
					Mean HSI		0.53

[1] $HSI = \frac{2(V1 + (V2 \times V3)) \times V4 + V5 + V6}{6}$

Bushy Lake Restoration Site, Baseline Conditions for the Grassland Area, as Determined from Field Sampling During March 2001.

Sample Plot No.	California Vole SIs				Plot	Owl FV SIs			Plot	Owl CRV SIs		Plot
	V_1	V_2	V_3	V_4	HSI [1]	V_1	V_2	V_4	HSI [2]	V_6	V_7	HSI [3]
1	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
2	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
3	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
4	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
5	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
6	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.67	1.00	0.10	1.00	0.46
7	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
8	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.83	1.00	0.10	1.00	0.46
9	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.50	1.00	0.10	1.00	0.46
10	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.18	1.00	0.10	1.00	0.46
11	1.00	0.70	1.00	0.40	0.78	1.00	0.87	0	0.87	0	1.00	0
12	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.18	1.00	0.10	1.00	0.46
13	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
14	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.18	1.00	0.10	1.00	0.46
15	1.00	1.00	1.00	0.70	0.93	1.00	1.00	0.18	1.00	0.10	1.00	0.46
16	1.00	1.00	1.00	0.40	0.85	1.00	0.20	0	0.20	0	1.00	0
17	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
18	1.00	1.00	1.00	0.10	0.78	1.00	1.00	0.18	1.00	0.10	1.00	0.46
19	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
20	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
21	1.00	0.90	1.00	0.40	0.83	1.00	1.00	0	1.00	0	1.00	0
22	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
23	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
24	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
25	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
26	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
27	1.00	1.00	1.00	0.40	0.85	1.00	1.00	0	1.00	0	1.00	0
28	0.85	0.02	1.00	0.70	0.64	1.00	1.00	0.18	1.00	0.10	1.00	0.46
			Mean HSI		0.86		Mean HSI		0.97	Mean HSI		0.12

[1] $HSI = \frac{V_1 + V_2 + V_3 + V_4}{4}$

[2] $HSI = (V_1 \times V_2) + V_4$ (not to exceed 1.0), where $V_4 < 50\%$; $(V_1 + V_2 + V_4)^{1/3}$, where $V_4 > 50\%$

[3] $HSI = (V_6 \times V_7^2)^{1/3}$

APPENDIX C

ASSUMPTIONS AND FUTURE CONDITIONS
PROJECTIONS, BY COVER-TYPE

AS USED IN THE ECOSYSTEM RESTORATION EVALUATIONS,
USING HABITAT EVALUATION PROCEDURES

APRIL 2001

I. WOODLAKE SITE

BASELINE CONDITIONS

1. *Existing Seasonal Wetland–10.96 acres.* Evaluation species HSIs are weighted means, derived from sampling of the two areas (8.36 and 2.60 acres). No significant changes of habitat conditions and values would occur over the analysis period relative to any evaluation species. Only Target Years (TYs) 0, 1, and 50 are necessary.

2. *Existing Seasonal Wetland Pits–6.94 acres.* Evaluation species HSIs are weighted means, derived from sampling of the two areas (4.80 and 2.14 acres). For the vole, herbaceous vegetation will gradually diminish, whereas logs and other cover on the ground will increase, resulting in no net changes of values over the analysis period. For SFCM, up to TY20 vegetation diversity, density (including detritus), and vertical stratification all increase. Then, from TY20-34, all variables remain constant. And from TY35-50, vegetation variables (except detritus) gradually decline. Thus, over the analysis period, there is no significant changes of SFCM conditions and values. Similarly, owl FV and owl CRV variables also remain constant. Only TYs 0, 1, and 50 are necessary.

3. *Existing Seasonal Wetland/Shrub–4.18 acres.* Evaluation species HSIs are weighted means, derived from sampling of the two areas (2.62 and 1.56 acres). For the vole, the new woody plants that are established at TY1 result in some clearing of herbaceous vegetation, thus lowering values until TY30 when values increase due to cover in the form of logs and branches starting to accumulate on the ground. However, the net effect for the vole is no significant overall changes of values over the analysis period. For owl FV, herbaeous vegetation declines while woody shrub cover increases, for no significant net overall changes of values over the analysis period. For owl CRV, large trees develop relatively quickly by TY15 from stock already existing on the site, with the number then gradually increasing to TY25, then remaining constant. For the vole and owl FV on TYs 0, 1, and 50 are necessary, whereas for owl CRV, TYs 0, 15, 25, and 50 are needed.

4. *Existing Riparian Forest–2.37 acres.* The stand is presently near climax condition, with little or no reproduction occurring. At TY20, snags, fallen whole trees, and new understory start to develop, continuing to TY50. This block of forest is a contiguous part of a >20-acre forested area. Vole, owl FV, and owl CRV will thus vary over the analysis period. TYs 0, 1, 20, and 50 are needed for each of these species.

5. *Riparian Forest/Permanent Wetland–20.91 acres.* Evaluation species HSIs are weighted means, derived from sampling of the two areas (16.77 and 4.15 acres). The stands have low-to-moderate reproduction occurring due to periodic flooding and fire events, which will largely continue current values. However, at TY20 log cover for voles begins a slow increase until TY50, resulting in increased vole values. Both owl values remain constant over the analysis period. TYs at 0, 1, 20, and 50 are used for all evaluation species.

6. *Mixed Riparian Forest–44.43 acres.* Evaluation species HSIs are weighted means, derived from sampling of the three areas (19.08, 15.69, and 9.66 acres). These stands are similar in attributes and futures as the Riparian Forest/Permanent Wetland described above. However, the vole improvements TY20-50 will be slightly less. TYs at 0, 1, 20, and 50 are used for all evaluation species.

7. *Riparian Oak Woodland–12.22 acres.* This is one contiguous stand. Existing values are high, due to diversity, including moderate seasonal-flooding-derived regeneration. Present values will continue uninterrupted, except at TY20-50 log cover for voles increases. However, overall vole HSI will not correspondingly increase, because of the frequent flooding events which will remove or lower vole populations over much of the stand. All three HSIs will remain constant over the analysis period. (However, both action alternatives would increase the contiguous size of the stand, thus increasing owl variable V_7 and corresponding HSI.) TYs at 0, 1, 20, and 50 are used for all evaluation species.

8. *Oak Woodland/Savannah–4.42 acres.* This one contiguous stand would be better classified as upland savannah, since there are few trees and essentially no tree reproduction at present. Existing values (vole and owl FV only) would continue over the analysis period. Only TYs 0, 1, and 50 are necessary.

9. *Mature Trees–0.99 acre.* These two small stands (sampled as one) are mature and not reproducing. As the stands become decadent, from TY20-50, vole and owl FV will increase slightly, whereas owl CRV will decline even further. (However, incorporating these sites into larger contiguous stands of forest types will increase owl CRV substantially by increasing V_7.) TYs 0, 1, 20, and 50 are used for all evaluation species.

10. *Cottonwoods–1.71 acres.* Evaluation species HSIs are weighted means derived from sampling the two areas (0.88 and 0.83 acre). Futures (and thus TYs) are the same as for Mature Trees above.

11. *Black Locust Grove–0.38 acre.* This single stand has moderate-to-high existing values, largely due to its connectivity to a much larger forested area. Present values will continue to be maintained over the analysis period. Only TYs 0, 1, and 50 are necessary.

12. *Ruderal–163.52 acres.* This is one contiguous area. Values here remain constant, except for periodic disturbance by fire. Each fire event dramatically but temporarily lowers vole and owl FV variables, which then quickly reestablish within 3 years of each fire event. Fire destroys about one-third of the ruderal area every 8.33 years, a scenario which can be approximated by accounting for a 100% fire event at 16 and 32 years. Therefore, TYs used for both the vole and owl FV are 0, 1, 16, 19, 32, 35, and 50.

13. *Elderberry Mitigation Planting–0.77 acre.* This mitigation site was not sampled. Due to the present sparse vegetation, existing vole and owl FV values are low–both 0.10 HSI. The

elderberries and other limited woody shrub natural recruitment reaches maximum canopy size and coverage at TY15, then remaining constant until TY50. Tys 0, 1, 15, and 50 are used.

ALTERNATIVE 1

1. *Seasonal Wetland (two sites)–6.95 acres.* The new area would be derived from existing Mixed Riparian Forest (1.08 acres), Seasonal Wetland (2.61 acres), and Ruderal area (2.26 + 1.00=3.26 acres). Evaluation species HSIs involve weighted means derived from these three areas. After clearing and grading of the two sites (3.34 and 3.61 aacres), rushes and sedges would be planted in one season and maintained until established at 2 years. Planting would entail both plugs (15 feet apart) and general drill-seeding with a native wetland plant mix. Full habitat values would be relatively quickly achieved in 5 years. Also, the 3.34-acre site would have immediately improved hydrologic connectivity to the river and flooding duration, whereas the hydrology of the 3.61-acre site would remain unchanged from baseline conditions. Full functioning value as measured by the SFCM would not be achieved until year 10, however. Appropriated TYs in the analyses of all species are 0, 1, 2, 5, 10, and 50.

2. *Seasonal Wetland Pits-(w/out stranding; two sites)–8.64 acres.* The new area would be slightly larger than the existing area of 6.94 acres. Of the additional 1.70 acres, 1.4 acres would not represent any cover-type conversion, but merely an additional area of Mixed Riparian Forest that would periodically be flooded due to the improved hydrologic connection to the river. However, 0.30-acre of Mixed Riparian Forest would be lost due to enlarging the areas where the two pits are connected to the river. These areas would need to be riprapped. The improved connections of the pits to the river would immediately and dramatically improve both hydrologic connectivity and inundation duration of the pits. The other SFCM variables would remain unchanged over the analysis period, however. The increases in flooding would not significantly reduce long-term small prey populations or the ability of raptors to utilize them. However, neither would it improve them, because increased flooding would tend to be a population-limiting factor. The improved hydrology of the pits would facilitate increased natural reproduction of woody plants, particularly cottonwoods, starting in 5 years. This in turn would cause several habitat variables to gradually improve, with maximum values reached in 50 years. Evaluation species HSIs are weighted means derived from the various acreage components. Appropriate TYs in the analyses are 0, 1, 5, 30, and 50.

3. *Riparian Forest (three sites)–48.24 acres.* The new forest area would be derived from existing forest areas (Cottonwoods–1.71 acres; Mixed Riparian Forest–1.67 acres; and Seasonal Wetland/Shrub–1.56 + 2.0=3.56acres) totaling 6.96 acres which would not be destroyed, and from Seasonal Wetland (8.36 acres) and Ruderal area (32.92 acres). All replanting would be completed in one season. The newly planted areas would gradually improve in condition and value over time, with significant milestones at 5, 15, and 30 years, after which values would begin to level off. However, average tree dbh (diameter at breast height) would continue increasing until all species reached or exceeded 20 inches after 50 years. Adding the various existing small forest plots to the larger blocks increases the smaller plots' values starting in 5

years. Evaluation species HSIs are mean values derived from considering all the components. Appropriate TYs in the analyses are at 0, 1, 5, 15, 30, and 50.

4. *Riparian Oak Woodland (two sites)–16.36 acres.* The new habitat would be derived from existing Ruderal area (15.79 acres) and Oak Woodland/Savannah (0.57 acre). The new woodland would be established by planting acorns and deepots, and maintaining the new plants for 5 years. Cover-cropping, erosion control, and tree damage by mammals would all be addressed during the maintenance period. Average tree dbh would increase more slowly than for Riparian Forest areas; after 50 years, oak dbh would only be 11-20 inches under optimal conditions which may not be achieved. Average dbh after 30 years would only be 6 inches. After 3 years, the cover crops provide good vole and owl FV values over the whole 16.36-acre area. Evaluation species HSIs are weighted means from the two component types. Appropriate TYs in the analyses are at 0, 1, 3, 10, 20, 30, and 50.

5. *Oak Woodland/Savannah (three sites)–48.73 acres.* The new area of this cover-type would be derived from existing Ruderal area (47.59 acres), a small plot of mature trees (0.27 acre), and Mixed Riparian Forest (0.87 acre). Tree and shrub plantings would be relatively sparse, at 150 feet and 50 feet apart, respectively. Shrubs would establish and grow quickly, reaching maximum size of 10-20-feet in height after 10 years. Oaks and other trees would grow much more slowly, with average dbh values as described above for Riparian Oak Woodland. Evaluation species HSIs are mean values from the three component areas. Appropriate TYs in the analyses are at 0, 1, 3, 10, 20, 30, and 50.

6. *Grassland (one large, contiguous area)–62.64 acres.* This feature would be derived from existing Ruderal area (61.92 acres) and a small stand of mature trees (0.72 acre). Where yellow star thistle was abundant, the top layer (about 12 inches) of soil would be removed and disposed of. Grasses would be drill-seeded and maintained weed-free for 5 years. Grassland cover values of importance to voles increase gradually for 15 years when they become maximum for the next 35 years. Evaluation species HSIs need be based only on the Ruderal area, since weightings including the small mature tree area do not significantly change any values. Appropriate TYs in the analyses are at 0, 1, 5, 10, 15, and 50.

7. *Shallow Aquatic (one site)–1.16 acres.* The new area would be derived from existing Mixed Riparian Forest (0.64 acre) and Ruderal area (0.52 acre). Low-stature wetlands plants, including rushes and sedges, would be planted as plugs 10 feet apart and maintained for 5 years. These plants would spread relatively quickly, achieving their maximum canopy coverage of 80% in 10 years. The area would continue to support voles (and other small mammals) for raptor foraging during dry periods when not inundated. Initial (Year 0) HSIs area weighted means from the two component areas, but thereafter one HSI for the whole area is considered. Appropriate TYs are 0, 1, 2, 5, 10, and 50).

ALTERNATIVE 2

1. *Seasonal Wetland (one site)–14.35 acres.* The new area would be derived from existing Seasonal Wetland (8.36 acres), Ruderal area (5.11 acres), and a small stand (0.88 acre) of cottonwoods, which would not be destroyed or modified. After clearing and grading, rushes and sedges would be planted using plugs placed 15 feet apart. The site would receive the same maintenance period (5 years) as in Alternative 2, however, no general drill-seeding of wetlands plants would be done as in Alternative 2. Achieving maximum habitat attributes would take slightly longer–5-10 years–than in Alternative 2, because of the lack of drill-seeding. Existing fish-stranding problems would not change, as no changes in hydrologic connection to the river would be made. Evaluation species HSIs for year 0 would be based on weighted means from the three component areas; thereafter, weighted means would be based on only two area–13.47 and 0.88 acres. Appropriate TYs are 0, 1, 5, 10, and 50.

2. *Seasonal Wetland Pits-(w/out stranding; two sites)–8.64 acres.* Same as Alternative 1.

3. *Riparian Forest (three sites)–27.77 acres.* Same as Alternative 1, except (a) the new area is derived from existing areas of Seasonal Wetland/Shrub (1.56 + 2.02=3.58 acres) and Mixed Riparian Forest (1.67 acres), neither of which would be destroyed or significantly modified, and Ruderal habitat (22.52 acres), which would be eliminated; and (b) evaluation species HSIs are weighted means considering all four of the component areas.

4. *Riparian Oak Woodland (two sites)–16.14 acres.* Same as Alternative 1, except that a slightly smaller new area (16.14 versus 16.36 acres) is created.

5. *Oak Woodland/Savannah (two sites)–29.08 acres.* Same as Alternative 1, except that a substantially smaller new area (29.08 versus 48.73 acres) would be created, thus eliminating only 27.94 rather than 47.59 acres of Ruderal habitat.

6. *Grassland (one medium-sized, contiguous area)–93.18 acres.* Same as Alternative 1, except that a substantially larger new area (93.18 versus 62.64 acres) would be created, by conversion of more Ruderal area to Grassland (versus forested types) than in Alternative 1.

II. URRUTIA SITE

<u>ALTERNATIVE 1</u>

1. *Riparian Forest - RFO1*. This forest area would be derived from 1.16 acres of high-value (as field measured) ruderal areas and 6.61 acres of zero value barren (degraded and compacted) area. The baseline analysis thus utilizes weighted mean HSIs and assumes constant values until TY 50. The ruderal area is not assumed to be periodically disturbed by fire (as at the Woodlake site), because there is no evidence of past fires on the site, and the vast majority of the area is presently barren. The new forested area would develop as described for the Woodlake site (*see* Appendix B-8; Woodlake). The newly forested area would also develop seasonal floodplain values after grading is done to tie it hydrologically to NEMDC/Bannon Slough. The SFCM values then develop similar to RIP1 (Alt.1) at the Woodlake site.

2. *Riparian Forest - RFO2*. This forested area would be derived from 1.55 acres of young cottonwoods, 17.67 acres of high value (as field measured) ruderal area and 48.09 acres of barren (degraded and compacted) area. The baseline analysis thus utilizes weighted mean HSIs and assumes constant values until TY50. The ruderal area is not assumed to be periodically disturbed by fire (as at the Woodlake site), because there is no evidence of past fires on the site, and the vast majority of the area is presently barren. The new forested area would develop as described for the Woodlake site (see Appendix B-8; Woodlake), but would not develop SFCM value since no changes to the site hydrology would occur.

3. *Riparian Forest - RFO3*. This forested area would be graded into three zones running parallel to the river: shallow aquatic (20%); seasonal wetland (20%) and riparian forest (60%). Thus, it would be physically and functionally similar to Measure 6 at the Woodlake site. The new habitats would be derived from 2.96 acres of low-value existing riparian vegetation. However, creation of these habitats would also necessitate removal of 0.76 acres of existing SRA Cover (15x2,225-ft), along the bank which has low-to-moderate value. Although SRA Cover would be removed, the three new cover-types to be created would each have SFCM values, which together would have equal or greater value then the SRA Cover values lost. In lieu of field-sampling (but based on visual inspection and analysis of 35mm color photographs), the existing riparian vegetation along the site, HSIs are all assumed to be 0.50, conditions which under the no-action alternative would persist to TY 50. Existing SRA Cover HSI is 0.22, as determined through analysis of 35mm color photographs (Appendix U6).

4. *Emergent Wetland - EW1*. This emergent wetland would consist of a narrow band created around the open water perimeter, by filling the nearshore area (3.18 acres) of this open water and grading back some of the nearshore bank (3.29 acres). All of the nearshore bank that would be impacted is presently barren, degraded, and compacted.

5. *Riparian Oak Woodland - ROW1*. This woodland area would be derived from the existing high-value ruderal area. Assumptions are thus similar to riparian forest (RFO3) above.

6. *Grassland - GR1*. This grassland area would be derived from 6.53 acres of existing high-value ruderal area, with characteristics as described above for riparian forest (RFO3) creation.

Development of habitat values associated with the grassland creation would be the same as for grassland at the Woodlake site.

ALTERNATIVE 2

1. *Riparian Forest - RFO1*. Same as Alternative 1, RFO1.

2. *Riparian Forest - RFO2*. This forest area would be derived from filling 16.31 acres of open water, conversion of 48.09 acres of barren (degraded and compacted) area, and modification of 13.91 acres of high-value (as field-measured) existing ruderal area. The baseline analysis and action analysis are otherwise the same as for polygon RFO2 in Alternative 1 above.

3. *Riparian Forest - RFO 3-4*. These two small areas total 1.45 acres, which would be graded into three zones just as for RFO3 in Alternative 1. All other assumptions and procedures are the same as for Alternative 1.

4. *Emergent Wetland - EW1-3*. This would entail creating three small patches of this cover-type roughly equally-spaced around the perimeter of the remaining open water area and derived from filling and grading open water area (4.61 acres). Otherwise assumptions and analysis paralleled that for EW1 of Alternative 2.

5. *Riparian Oak Woodland - ROW1*. Same as ROW1 for Alternative 1, except the area created is 10.70 acres.

6. *Grassland - GR1-2*. Same as GR1, Alternative 1, except two patches totaling 9.51 acres would be created.

7. *Seasonal Wetland (SW1) and Shallow Aquatic (SAQ1).* This action, equivalent to JSA's Measure 13 (Table 1b) would total 8.23 acres (SW1=7.15 acres; SAQ1=1.08 acres). The SW1 area would be derived from 5.15 acres of open water, 1.67 acres of barren (degraded and compacted) area, and 0.33 acre of existing riparian vegetation; in addition, 0.09 acre of SRA Cover (250 x 15-ft) would be destroyed by the grading/re-contouring process. The SAQ1 area would be derived from 0.15 acre of open water, 0.73 acre of barren area, and 0.20 acre of existing riparian vegetation; in addition 0.05 acre of SRA Cover (150 x 15-ft) would be destroyed by the grading/re-contouring. The new 8.23 acre area will gain SFCM values, but lose OWM and SRA values.

III. BUSHY LAKE SITE

ALTERNATIVE 1

1. *Emergent Wetland - EW1.* This 0.39-acre area would be derived from existing riparian forest and riparian forest/permanent wetland areas. These existing areas are very similar in structure and habitat value to the existing riparian forest/permanent wetland area of 16.77 acres on the Woodlake site. Therefore, the evaluation species baseline measurements made at Woodlake can be used for describing the baseline for this small habitat conversion. After clearing and grading of the site, emergent wetland plants would be planted as plugs (10 feet apart). Full habitat values would be relatively quickly achieved, the same as at the Urrutia site. This would constitute a conversion from a high-value cover-type to a high-value cover-type. In absence of the proposed action, the baseline values of the site would be maintained as is over the analysis period.

2. *Riparian Forest - RFO1.* This 9.46-acre forested area would be derived from existing oak/walnut/elderberry savannah by grading and planting. The new forest would develop just as for the forest proposed to be created at the Woodlake or Urrutia sites. Baseline conditions for evaluation species at the site were field-measured during March 2001. Without any action, this site would be periodically disturbed by fire, just as for the existing ruderal area at the Woodlake site.

3. *Riparian Forest - RFO3.* This 1.99-acre block of new forest would be derived from existing ruderal area which is quite similar in structure and habitat value to the existing ruderal area of the Woodlake and Urrutia sites. Baseline values from the Urrutia site can be used to represent baseline values of this site, which would be expected to be periodically disturbed by fire (as at the Woodlake site). Forest re-creation would also occur as at the Woodlake and Urrutia sites (where grading would not be involved).

4. *Riparian Forest - RFO2.* This 20.33-acre forested area would involve a habitat conversion and resulting new habitat creation the same as RFO1 described above.

5. *Riparian Forest - RFO4.* This 1.37-acre re-forestation would occur within an existing 2.30-acre oak/cottonwood riparian area (with some exotic woody species) with moderate-to-high existing habitat values. The area to be re-forested (and have exotics removed) is quite similar in structure and value to the existing 2.37-acre riparian forest area (non-impacted) at the Woodlake site. Baseline values measures at this Woodlake site can be applied at this area, after adjusting the owl CRV value downwards to account for the smaller "patch" size at the Bushy Lake plot.

6. *Oak Savannah - OS1.* This 89.20 acres would involve planting trees and understory species to improve the existing oak/walnut/elderberry savannah. This existing savannah was sampled to determine baseline conditions for evaluation species. The planting "enhancements" would develop over time just as would similar oak-community plantings at the Woodlake and Urrutia sites. Under the baseline condition, fire would periodically reduce habitat values just as for the ruderal area at the Woodlake site.

7. *Oak Woodland - OW1.* This 2.75-acre area would be derived by removing several non-native pines and cypress, and planting this, and the adjacent elderberry savannah with native oaks. The

elderberry savannah has the same baseline values as the oak/walnut/elderberry savannah which was extensively sampled. The existing 0.68-acre pine and cypress grove has the same baseline values as the 2.37-acre riparian forest are (non-impacted) at the Woodlake site (after adjusting for its smaller "patch" size). The existing savannah habitat is assumed to be periodically reduced in value by fire, just as for the ruderal area at the Woodlake site.

8. *Shallow Aquatic - SAQ1.* This 0.93-acre area is an existing moderately-to-highly vegetated floodplain zone for which the connectivity to the river would be improved to allow free flow and to eliminate fish stranding depressions. The necessary improvements to hydrology would necessitate temporary removal of about one-third of the cover on the 0.93-acre area. Currently, the existing floodplain zone is flooded less than 10% of the time during January - March, which would be improved to 75-90% flooding during January-March annually. Improvements in SFCM values would generally mirror those for the seasonal wetland "pits" that would be improved at the Woodlake site.

9. *Riparian Forest - RIP6.* This 3.06 acres of new forest habitat would be created by replanting after first removing (and grading) 0.15 acre (650 x 10-feet) of SRA cover, 0.30-acre of black locust grove, 0.30-acre of oak/ash woodland, 0.45-acre (650 x 30-feet) of riparian scrub-forest along the steep, eroding bank, and 2.01 acres of existing oak/walnut/elderberry savannah. All of these existing habitats, except black locust grove (used Woodlake black locust grove values), were field-sampled to determine their baseline conditions for the evaluation species. Although 650 feet of SRA cover along the steep bank would be lost, SFCM habitat would be created within the new forested area.

10. *Seasonal Wetland - SW1.* The 0.79-acre of new habitat would be part of the action creating RIP6 above. Habitat that would be removed in the process includes 0.05 acre of SRA Cover (225 x 10 feet), 0.10 acre of black locust grove, 0.15 acre of oak/ash woodland, and 0.15 acre of riparian scrub-forest (225 x 30-feet) along the steep, eroding bank, and 0.39 acre of existing oak/walnut/elderberry savannah. Existing and future values were derived as for RIP6 above. Although 225 feet of SRA Cover along the steep bank would be lost, SFCM habitat would be gained in the seasonal wetland, which would mirror the similar seasonal wetland proposed for the Woodlake site.

11. *Shallow Aquatic - SAQ2.* The 0.36 acre of new habitat would be part of the action creating RIP6 and SW1 above. Habitat that would be removed in the process includes 0.02 acre of SRA cover (100 x 10-feet), 0.10 acre of black locust grove, 0.07 acre of riparian scrub-forest (100 x 30-feet) along the steep eroding bank, and 0,19 acre of existing oak/walnut/elderberry savannah. Although 100 linear feet of SRA Cover would be lost forever, SFCM habitat would be gained in the shallow aquatic area, which would mirror the similar seasonal shallow aquatic areas proposed at the Woodlake and Urrutia sites.

12. *Riparian Forest - RFO(X).* This 4.0 acres would be part of an action along about 1,525 linear feet of steep bank at the upstream end of the site to create three terraced cover-types:

riparian forest (60%), seasonal wetland (20%), and shallow aquatic (20%). The action would involve grading and terracing about a 200-foot-wide strip along the bank and establishing appropriate plants for each cover-type. The land-ward, flat, high-terrace strip of about 120 feet (60% of 200) would impact an existing 4.0-acre riparian zone of moderate habitat value which would be removed during the grading and terracing process. This impact area was field-sampled to assess baseline conditions for the evaluation species during March 2001. Lowering and grading this high terrace strip will result in some new SFCM habitat (½ the strip, or 2.0 acres) which does not presently exist. The overall loss of 0.35 acre of SRA cover (1,525 x 10-feet) that would occur with the action is allocated by percentages (60-20-20%) to the three cover-types that would be created.

13. + *Seasonal Wetland - NA.* This 1.34-acre zone would be part of the above action (#12) to create RFO(X). The 1.34 acres would be derived from 1.34 acres of existing flat, high-terrace riparian area which was field-sampled during March 2001. Although 0.07 acre of SRA cover (20% of 0.35 acre) would be destroyed, 1.34 acres of new SFCM habitat would be created. This SFCM habitat would have somewhat higher value than in #12 above, because it would be lower, and thus more frequently flooded.

14. + *Shallow Aquatic - NA.* This 1.34-acre zone would be part of the above actions (#12-13) to create RFO(X) and Seasonal Wetland habitat. The 1.34 acres would be derived from along the steep riverside edge of the existing site, which was field-sampled during March 2001. Although 0.07 acre of SRA cover (20% of 0.35 acre) would be destroyed, 1.34 acres of new SFCM habitat would be created. This SFCM habitat would have high values due to low elevation creating frequent inundation.

ALTERNATIVE 2

1. *Riparian Forest - RFO1.* Same as Alternative 1, RFO2 (item #4 above), except for the acreage.

2. *Oak Savannah - OS1.* Same as Alternative 1, OS1 (item #6 above), except for the acreage.

3. *Oak Savannah - OS2.* Same as Alternative 1, OS1 (item #6 above), except for the acreage.

4. *Oak Woodland - OW1.* Same as Alternative 1, OW1 (item #7 above), except for the acreage.

5. *Grassland - GR1.* This 30.76-acre area would be created from existing oak/walnut/elderberry savannah, with little or no impact to the existing woody species. Existing values were field-measured during March 2001. Future conditions would mirror conditions for grasslands that would be created at the Woodlake and Urrutia sites. Conversion from the existing ruderal/annual grass understory to native grassland is assumed to reduce the periodic losses of the area to fire.

6. *Riparian Forest - RFO3.* Same as Alternative 1, RIP6 (item #9 above).

7. *Seasonal Wetland - SW1.* Same as Alternative 1, SW1 (item #10 above).

8. *Shallow Aquatic - SAQ1.* Same as Alternative 1, SAQ2 (item#11 above).

9. *Riparian Forest - RFO(X).* Same as Alternative 1, RFO(X) (item #12 above).

10. + *Seasonal Wetland - NA.* Same as Alternative 1, + Seasonal Wetland (item #13 above).

11. + *Shallow Aquatic - NA.* Same as Alternative 1, + Shallow Aquatic (item #14 above).

IV. ARDEN BAR SITE

ALTERNATIVE 1

1. *Willow Scrub - WS1.* This 2.69-acre strip along the north side of the proposed high-flow channel would be derived from existing open water (1.94 acres), rock cobble (0.62 acre), and ruderal/herbaceous area (0.13 acre). The area also currently serves as low-value seasonal floodplain habitat (2.69 acres). The proposed earthwork and planting would be completed in 1 year. Willow species would achieve moderate to high densities, but height and d.b.h. would be limited to 25 feet and 1 foot, respectively. Maximum habitat values would be achieved relatively quickly, in 15 years. Existing habitat values of the strip were field-sampled for the evaluation species during March 2001. Following construction, SFCM values will also increase due to the increased cover and slightly increased inundation periodicity.

2. *Willow Scrub - WS3.* This 0.24-acre patch is the same as for WS1 above, except for its size and that it would be derived from 0.11 and 0.13 acre of open water and ruderal/herbaceous area, respectively.

3. *Willow Scrub - WS3.* This 1.52-acre strip along the south side of the proposed high-flow channel is the same as for WS1-2 above, except for its size and that it would be derived completely from existing open water area which has OWM value of 0.50 and low SFCM value of 0.08, which would eventually maximize at 0.25 HSI, due to improvements in hydrology and cover aspects.

4. *Riparian Forest - RFO1.* On an earlier plan, this 15.89-acre area was part of a proposed 23.42 acre willow/cottonwood/scrub complex. The 15.89 acres of riparian forest would be derived from an existing patch of cottonwood-willow (0.40 acre), area where the Sheriff’s Training Facility levee would be removed (Developed Recreation = 3.44 acres), and ruderal/herbaceous area (12.05 acres). These existing areas were field-sampled during March 2001 for the evaluation species. Under the proposal, all work, including the initial planting would be done in 1 year. The new forested area would then develop just as at the other three restoration sites where this cover-type would be established. Half of the existing area also currently has low

SFCM values during infrequent flooding from high flows. Plan implementation (especially the grading process) would reduce all of the developed recreation area values and one-fourth o (4.0 acres) of the remaining existing area values to zero, while all other existing area values would be unaffected (*i.e.*, no other reductions to existing evaluation species values). The low SFCM values over one-half the action area would be slightly increased under the proposed action.

5. *Riparian Forest - RFO2.* This (1.12-acre) polygon, formerly designated as willow/cottonwood scrub would be derived from filling in open water (1.12 acres) of the pond. The existing open water conversion would be similar to WSG3 above (#3), except the riparian forest being established would develop just as at the other proposed restoration sites and not as the smaller, "scrub" vegetation of WSG3.

6. *Riparian Forest - RFO3.* This 0.99-acre polygon is the same as RFO2 above (#5), except for the slightly different size.

7. *Riparian Forest - RFO4.* In this scenario, the two small islands in the center of the pond, which currently total 0.65 acres, would be enlarged (and joined together) to 1.01 acres (with 0.36 acre of new area derived from existing open water) and then the whole area would be reforested. Non-native invasive plants would first be removed, for an initial loss of 0.25 acres of existing vegetative cover. Re-growth of the newly forested area would occur just as at the other sites and polygons. The existing willow scrub and non-native invasive plant areas of the islands were field-sampled to assess HSIs during March 2001.

8. *Riparian Forest - RFO5.* This 5.49-acre polygon earlier was part of a 23.42-acre willow/cottonwood scrub polygon. Now, this area would essentially all be derived from filling, grading, and planting open water area of the pond. As such, it would be identical to polygons RFO2 and RFO3 above, except for its larger acreage.

9. *Riparian Forest - RFO6.* This 2.06-acre area would be derived from existing bare ground (0.50 acre), open water (0.40 acre), and ruderal/herbaceous area (1.16 acre). The latter area was part of the area sampled for HSI determinations during March 2001. Establishment of the forest after grading and planting would occur just as at other areas. The grading and planting activity, however, would temporarily reduce all of the existing ruderal/herbaceous area value to zero. Currently, only about 1.0 acre of the existing overall area has any low values for SFCM. The other 1.06 acres is too high in elevation and has no existing values. The construction would create moderately low SFCM values over all of the area, however.

10. *Shallow Aquatic - SAQ1.* This 0.51 acre area would be derived from 0.45 acre of barren rock cobble and 0.06 acre of ruderal/herbaceous area, but for HEP accounting the whole 0.51-acre area can be assumed to be rock cobble with moderate existing (HSI = 0.45) SFCM value which was field-measured during March 2001. This shallow aquatic habitat would be essentially the same in all respects to similar areas proposed at the Woodlake, Urrutia, and Bushy Lake sites,

except that SFCM variable V_6 would equal 1.0, because of the relatively lengthy (>6 weeks) construction.

11. *Emergent Wetland - EW1-6.* These six proposed polygons would range from only 0.1 to 0.3 acre in size and total 1.17 acres. Analyzing each small polygon individually would have been costly and unnecessarily complex. Therefore, the combined 1.17 acres were evaluated as one unit. Most of the total acreage would be derived from open water (0.80 acre) which would be filled in and planted with emergent species. Also, there would be 0.25-acre of essentially barren-ruderal area with zero existing values, and 0.13 acre of ruderal/herbaceous area involved in the conversion to emergent wetland patches. Development of the new emergent wetland patches would be the same as at the other restoration sites.

12. *Oak Woodland/Savannah - OWS1.* This 21.27 acre polygon would be derived from existing ruderal/herbaceous area (20.26 acres) and open water (1.01 acres) are which would be filled in. The ruderal/herbaceous area has low-to-moderate existing values (including low SFCM value over 5.0 acres) which were assessed by field-sampling during March 2001. After the grading and planting, the development and values of the new oak woodland plants would be the same as projected at the other restoration sites where this cover-type is proposed. The grading and earthwork would temporarily destroy habitat values over 25% (4.0 acres) of the 21.27-acre site.

13. *Oak Woodland/Savannah - OWS2.* This 6.41 acre area would be derived from the developed recreation area now being used by the Sheriff as a training facility. Currently, the 6.41 acres is assumed to have zero value for the evaluation species. After planting, development of structure and habitat values would be just as at other similar sites. There would not be any new SFCM values created, however.

14. *Oak/Woodland Savannah - OWS3.* This area of 1.13 acres would be derived from the same amount of oak upland/yellow starthistle patch. The area was field-sampled during March 2001. It currently has low SFCM values along with the various terrestrial-species values. A slight increase would occur to the SFCM values, because the floodplain would not be lowered but would develop improved overhead cover and other food and cover elements of the SFCM. The implementation would temporarily reduce Vole and Owl FV values to zero while starthistle was eradicated.

15. *High-Flow Channel - HFC1.* This feature would be derived from existing open water (5.26 acres), ruderal/herbaceous area (1.20 acres), and barren cobble area (0.46 acre). The entire area presently has low SFCM values due to lack of cover and low inundation frequency. The action would not appreciably increase cover, but would greatly increase inundation periodicity during January - April and thus dramatically improve SFCM values. However, the action would essentially “zero out” the existing low terrestrial habitat values of the site and existing open water value.

<u>ALTERNATIVE 2</u>

16. *Riparian Forest - RFO1.* This polygon is essentially the same as polygon RFO1 in Alternative 1, except for a slightly different shape and thickness in certain areas, which results in 22.57 total acres versus 15.89 (in Alternative 1). Therefore, both the baseline and action AAHUs can be calculated as proportions of the values actually calculated for RFO1 in Alternative 1.

17. *Riparian Forest/Reshape Bank - RB1.* This 4.33 acres would all be derived from placing fill into pond areas, reshaping banks, and planting riparian forest species. Thus, only open water of 4.33 acres would be impacted. In addition to the normal OWM values this area also has low existing SFCM values. Riparian forest would develop just as at other proposed polygons and sites. SFCM values would be slightly increased due to improved cover conditions, but hydrology would not change.

18. *Riparian Forest/Reshape Bank - RB2.* This 3.42 acre polygon is identical in all respects to RB1 above (#17), except in size and shape. All baseline and action values for evaluation species can be calculated from simple proportions (comparing to RB1).

19. *Emergent Wetland - EW1-6.* The six small polygons of this feature, which total 0.96 acre, all nearly identical to the six from Alternative 1, except for insignificant differences in sizes and where they are sited. Therefore, all baseline and action HSI values (and AAHUs) for evaluation species can be calculated from the Alternative 1 results, using proportions (compared to the 1.17 acres of EW1-6 in Alternative 1).

20. *Oak Woodland/Savannah - OWS1.* This 6.41-acre area is the same as OWS2 in Alternative 1 above (#13).

21. *Oak Woodland/Savannah - OWS2.* This 13.13-acre area would be a reduced version of the OWS1 polygon in Alternative 1 (#12 above). The whole acreage would be derived from existing ruderal herbaceous area with low-to-moderate habitat values for evaluation species. However, unlike OWS1 in Alternative 1, this proposed area has no existing SFCM values, nor would any be created, since no grading and lowering would occur. All existing vegetation and associated and values would remain undisturbed. Thus, with the site already jump-started, the long-term oak woodland/savannah values would be somewhat accelerated compared to planting a completely barren area.

22. *Oak Woodland/Savannah - OWS3.* This 1.13-acre area is the same as OWS3 in Alternative 1 above (#14).

23. *Oak Woodland - RLOW1.* This 3.33-acre area would be derived from about 1.00 acre of existing ruderal/herbaceous area and 2.33 acres of either cobble or bare ground which currently has zero value for the terrestrial evaluation species. The existing values on the ruderal/herbaceous portion were field-measured during March 2001. The whole 3.33-acre area also currently has low SFCM values, which would drop to zero with the proposed action (*i.e.*,

raising low areas to create a levee at the site be fore planting). We must also assume that the filling activity would temporarily reduce to zero the existing ruderal/herbaceous values.

APPENDIX D

HEP ACCOUNTING WORKSHEETS SHOWING DERIVATION
OF AAAHUs FROM AAHUs AS ADJUSTED
USING RVIs

AS USED IN THE ECOSYSTEM RESTORATION EVALUATIONS
USING HABITAT EVALUATION PROCEDURES

APRIL 2001

Urrutia Restoration Site Worksheet to Derive Total AAAHUs by Measure and Cover-Type, Using AAHUs Derived Through the HEP Accounting Process.

MEAS.	COVER-TYPE AND ALTERNATIVE	ACRES	CA VOLE		OWL FV		OWL CRV		SFCM		OWM	
			AAHUs	AAAHUs[1]	AAHUs	AAAHUs[2]	AAHUs	AAAHUs[3]	AAHUs	AAAHUs[4]	AAHUs	AAAHUs[5]
6,7	RFO1-B	7.77	1.09	0.22	1.01	0.30	0	0	0	0	0	0
	RFO1-1	7.77	5.36	1.07	6.23	1.87	5.28	2.11	4.74	4.74	0	0
	RFO1-2	7.77	1.09	0.22	1.01	0.30	0	0	0	0	0	0
	RFO2-B	67.31	17.50	3.50	17.50	5.25	0	0	0	0	0	0
	RFO2-1	67.31	46.55	9.31	54.01	16.20	47.50	19.00	0	0	0	0

MEAS.	COVER-TYPE AND ALTERNATIVE	ACRES	CA VOLE		OWL FV		OWL CRV		SFCM		OWM		EMM		TOTAL AAAHUs[7]
			AAHUs	AAAHUs[1]	AAHUs	AAAHUs[2]	AAHUs	AAAHUs[3]	AAHUs	AAAHUs[4]	AAHUs	AAAHUs[5]	AAHUs	AAAHUs[6]	
	RFO2-B	78.31	13.02	2.60	12.40	3.72	0	0	0	0	6.52	1.3	0	0	7.62
	RFO2-2	78.31	54.09	10.82	62.72	18.82	53.17	21.27	0	0	0.06	0.01	0	0	50.92
8	ROW1-B	4.35	4.05	0.81	3.91	1.17	0	0	0	0	0	0	0	0	1.98
	ROW1-1	4.35	3.59	0.72	3.83	1.15	1.33	0.53	0	0	0	0	0	0	2.4
	ROW1-B	10.70	9.95	1.99	9.63	2.89	0	0	0	0	0	0	0	0	4.88
	ROW1-2	10.70	8.83	1.77	9.42	2.83	3.27	1.31	0	0	0	0	0	0	5.91
15	RFO3-B	1.78	0.89	0.18	0.89	0.27	0.89	0.36	0	0	0	0	0	0	0.98
	RFO3-1	1.78	1.24	0.25	1.43	0.43	1.22	0.49	1.03	1.03	0	0	0	0	2.20
	RFO3-4-B	1.45	0.73	0.15	0.73	0.22	0.73	0.29	0	0	0	0	0	0	0.80
	RFO3-4-2	1.45	1.01	0.20	1.17	0.35	0.99	0.40	0.84	0.84	0	0	0	0	1.79
	SA-NA-B	0.59	0.30	0.06	0.30	0.09	0.30	0.12	0	0	0	0	0	0	0.27
	SA-NA-1	0.59	0.52	0.10	0.55	0.17	0	0	0.40	0.40	0	0	0	0	0.67
	SA-NA-B	0.48	0.24	0.05	0.24	0.07	0.24	0.10	0	0	0	0	0	0	0.22
	SA-NA-2	0.48	0.43	0.09	0.45	0.14	0	0	0.32	0.32	0	0	0	0	0.55
15	SW-NA-1	0.59	0.52	0.10	0.55	0.17	0	0	0.40	0.40	0	0	0	0	0.67
	SW-NA-B	0.48	0.24	0.05	0.24	0.07	0.24	0.10	0	0	0	0	0	0	0.22
	SW-NA-2	0.48	0.43	0.09	0.45	0.14	0	0	0.32	0.32	0	0	0	0	0.55
10	GR1-B	6.53	6.07	1.21	5.88	1.76	0	0	0	0	0	0	0	0	2.97
	GR1-1	6.53	6.08	1.22	6.20	1.86	0	0	0	0	0	0	0	0	3.08
	GR1-2-B	9.51	8.84	1.77	8.56	2.57	0	0	0	0	0	0	0	0	4.34
	GR1-2-1	9.51	8.85	1.77	9.02	2.71	0	0	0	0	0	0	0	0	4.48
13	SAQ1-B	1.08	0	0	0	0	0	0	0	0	0.06	0.01	0	0	0.02

	SAQ1-2	1.08	0.95	0.19	1.01	0.30	0	0	0.72	0.72	0	0	0	0	1.21
	SW1-B	7.15	0.17	0.03	0.17	0.05	0	0	0	0	2.06	0.41	0	0	0.51
	SW1-2	7.15	6.31	1.26	6.65	2.00	0	0	3.21	3.21	0	0	0	0	6.47
17	EW1-B	6.47	0	0	0	0	0	0	0	0	1.27	0.25	0	0	0.25
	EW1-1	6.47	0	0	0	0	0	0	0	0	0.02	0	5.50	2.20	2.20
	EW1-2-B	4.61	0	0	0	0	0	0	0	0	1.84	0.37	0	0	0.37
	EW1-2-2	4.61	0	0	0	0	0	0	0	0	0	0	3.42	1.37	1.37

1. AAAHU for the CA Vole is determined by multiplying the AAHU by the RVI of 0.2.

2. AAAHU for the Owl FV is determined by multiplying the AAHU by the RVI of 0.3.

3. AAAHU for the Owl CRV is determined by multiplying the AAHU by the RVI of 0.4.

4. AAAHU for the SFCM is determined by multiplying the AAHU by the RVI of 1.0.

5. AAAHU for the OWM is determined by multiplying the AAHU by the RVI of 0.2.

6. AAAHU for the EMM is determined by multiplying the AAHU by the RVI of 0.4.

7. The values for the SRA AAHUs and AAAHUs are included in the total column but are not listed in the table. The RVI for SRA is 1.0.
RFO3B - AAHU (0.17), AAAHU (0.17)
RFO3-4B - AAHU (0.14), AAAHU (0.14)
SAQ1-2B - AAHU(0.01), AAAHU (0.01)
SW1-B - AAHU (0.02), AAAHU (0.02)

Bushy Lake Worksheet to Derive Total AAAHUs by Measure and Cover-Type, Using AAHUs Derived Through the HEP.

MEAS.	COVER-TYPE AND ALTERN.	ACRES	CA VOLE		OWL FV		OWL CRV		SFCM		SRA		EMM		TOTAL AAAHUs[7]
			AAHUs	AAAHUs[1]	AAHUs	AAAHUs[2]	AAHUs	AAAHUs[3]	AAHUs	AAAHUs[4]	AAHUs	AAAHUs[5]	AAHUs	AAAHUs[6]	
7	RFO1-B	9.46	5.53	1.11	6.38	1.91	1.14	0.46	0	0	0	0	0	0	3.48
	RFO1-1	9.46	6.60	1.32	7.66	2.30	6.43	2.57	0	0	0	0	0	0	6.19
	RFO1-B	20.17	11.79	2.36	13.60	4.08	2.42	0.97	0	0	0	0	0	0	7.41
	RFO1-2	20.17	14.07	2.81	16.33	4.90	13.72	5.49	0	0	0	0	0	0	13.20
	RFO2-B	20.33	11.88	2.38	13.71	4.11	2.44	0.98	0	0	0	0	0	0	7.47
	RFO2-1	20.33	14.18	2.84	16.46	4.94	13.83	5.53	0	0	0	0	0	0	13.31
6	RFO3-B	1.99	1.26	0.25	1.25	0.38	0	0	0	0	0	0	0	0	0.63

MEAS.	COVER-TYPE AND ALTERN.	ACRES	CA VOLE		OWL FV		OWL CRV		SFCM		SRA		EMM		TOTAL AAAHUs[7]
			AAHUs	AAAHUs[1]	AAHUs	AAAHUs[2]	AAHUs	AAAHUs[3]	AAHUs	AAAHUs[4]	AAHUs	AAAHUs[5]	AAHUs	AAAHUs[6]	
	RFO3-1	1.99	1.39	0.28	1.61	0.48	1.35	0.54	0	0	0	0	0	0	1.30
	RFO4-B	1.37	0.63	0.13	0.85	0.26	0.77	0.31	0	0	0	0	0	0	0.70
	RFO4-1	1.37	1.00	0.20	1.27	0.38	0.97	0.39	0	0	0	0	0	0	0.97
15	RFO(X)-B	4.02	2.77	0.55	3.38	1.01	0.92	0.37	0	0	0.11	0.11	0	0	2.04
	RFO(X)-1	4.02	2.80	0.56	3.25	0.98	2.74	1.10	1.35	1.35	0.01	0.01	0	0	4.00
	RFO(X)-2	4.02	2.80	0.56	3.25	0.98	2.74	1.10	1.35	1.35	0.01	0.01	0	0	4.00
	+SW-B	1.34	0.92	0.18	1.13	0.34	0.31	0.12	0	0	0.04	0.04	0	0	0.68
	+SW-1	1.34	1.18	0.24	1.27	0.38	0.01	0.01	0.91	0.91	0.01	0.01	0	0	1.55
	+SW-2	1.34	1.18	0.24	1.27	0.38	0.01	0.01	0.91	0.91	0.01	0.01	0	0	1.55
	+SA-B	1.34	0.87	0.17	1.05	0.32	0.44	0.18	0	0	0.04	0.04	0	0	0.71
	+SA-1	1.34	1.18	0.24	1.27	0.38	0.01	0.01	1.06	1.06	0.01	0.01	0	0	1.70
	+SA-2	1.34	1.18	0.24	1.27	0.38	0.01	0.01	1.06	1.06	0.01	0.01	0	0	1.70
13	RIP6-B	3.06	2.24	0.45	2.55	0.77	0.67	0.27	0	0	0.08	0.08	0	0	1.57
	RIP6-1	3.06	2.13	0.43	2.47	0.74	2.09	0.84	1.89	1.89	0.01	0.01	0	0	3.91
	RFO3-2	3.06	2.13	0.43	2.47	0.74	2.09	0.84	1.89	1.89	0.01	0.01	0	0	3.91
13	SW1-B	0.79	0.58	0.12	0.67	0.20	0.22	0.09	0	0	0.03	0.03	0	0	0.44
	SW1-1	0.79	0.70	0.14	0.74	0.22	0.01	0.01	0.53	0.53	0.01	0.01	0	0	0.91
	SW1-2	0.79	0.70	0.14	0.74	0.22	0.01	0.01	0.53	0.53	0.01	0.01	0	0	0.91
	SAQ2-B	0.36	0.26	0.05	0.29	0.09	0.11	0.04	0	0	0.02	0.02	0	0	0.20
	SAQ2-1	0.36	0.25	0.05	0.24	0.07	0.01	0.01	0.24	0.24	0.01	0.01	0	0	0.38
	SAQ1-2	0.36	0.25	0.05	0.24	0.07	0.01	0.01	0.24	0.24	0.01	0.01	0	0	0.38
1,8	OW1-B	2.75	1.52	0.30	1.82	0.55	0.63	0.25	0	0	0	0	0	0	1.10
	OW1-1	2.75	2.42	0.48	2.65	0.80	1.16	0.46	0	0	0	0	0	0	1.74
	OW1-B	2.57	1.42	0.28	1.69	0.51	0.61	0.24	0	0	0	0	0	0	1.03

	OW1-2	2.57	2.25	0.45	2.48	0.74	1.09	0.44	0	0	0	0	0	0	1.63
9	OS1-B	89.20	52.15	10.50	60.14	18.04	10.70	4.28	0	0	0	0	0	0	32.82
	OS1-1	89.20	81.08	16.22	88.91	26.67	32.65	13.06	0	0	0	0	0	0	55.95
	OS1-B	33.53	19.60	3.92	22.61	6.78	4.02	1.61	0	0	0	0	0	0	12.31
	OS1-2	33.53	30.48	6.10	33.42	10.03	12.27	4.91	0	0	0	0	0	0	21.04
	OS2-B	46.87	27.40	5.48	31.60	9.48	5.62	2.25	0	0	0	0	0	0	17.21
	OS2-2	46.87	42.60	8.52	46.72	14.02	17.15	6.86	0	0	0	0	0	0	29.40
16	SAQ1-B	0.93	0.70	0.14	0.89	0.27	0.59	0.24	0.32	0.32	0	0	0	0	0.97
	SAQ1-1	0.93	0.69	0.14	0.91	0.27	0.61	0.24	0.80	0.80	0	0	0	0	1.45
18	EW1-B	0.39	0.19	0.04	0.26	0.08	0.24	0.10	0	0	0	0	0	0	0.22
	EW1-1	0.39	0	0	0	0	0	0	0	0	0	0	0.33	0.13	0.13
10 +1,2, or 3	GR1-B	30.76	17.98	3.60	20.74	6.22	3.69	1.48	0	0	0	0	0	0	11.30
	GR1-2	30.76	28.61	5.72	29.21	8.76	3.69	1.48	0	0	0	0	0	0	15.96

Arden Bar Worksheet to Derive Total AAAHUs by Measure and Cover-Type, Using AAHUs Derived Through the HEP Accounting Process.

MEAS.	COVER-TYPE/ ALTERN.	AREA	CA VOLE		OWL FV		OWL CRV		SFCM		OWM		EMM		TOTAL AAAHUs
			AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	
22	WS1-(B)1	2.69	0.10	0.02	0.13	0.04	0.02	0.01	0.22	0.22	0.97	0.29	0	0	0.58
	WS1-1	2.69	2.30	0.46	2.42	0.73	1.14	0.46	0.62	0.62	0.01	0	0	0	2.27
	WS2-(B)1	0.24	0.10	0.02	0.13	0.04	0.02	0.01	0.02	0.02	0.06	0.02	0	0	0.11
	WS2-1	0.24	0.21	0.04	0.22	0.07	0.10	0.04	0.06	0.06	0	0	0	0	0.21
	WS3-(B)1	1.52	0	0	0	0	0	0	0.12	0.12	0.76	0.23	0	0	0.35
	WS3-1	1.52	1.30	0.26	1.36	0.41	0.65	0.26	0.35	0	0	0	0	0	1.28
7, 24	RFO1-(B)1	15.89	14.05	2.81	15.37	4.61	6.31	2.52	1.19	0	0	0	0	0	11.13
	RFO1-1	15.89	14.49	2.90	14.99	4.50	10.77	4.31	3.70	0	0	0	0	0	15.41
	RFO1-(B)2	22.57	19.96	4.00	21.83	6.55	8.96	3.58	1.69	0	0	0	0	0	15.82

Arden Bar Worksheet (cont.)

MEAS.	COVER-TYPE/ ALTERN.	AREA	CA VOLE		OWL FV		OWL CRV		SFCM		OWM		EMM		TOTAL AAAHUs
			AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	
	RFO1-2	22.57	20.58	4.12	21.29	6.39	15.30	6.12	5.26	0	0	0	0	0	21.89
7	RFO2-(B)1	1.12	0	0	0	0	0	0	0.09	0.09	0.56	0.17	0	0	0.26
	RFO2-1	1.12	0.77	0.15	0.90	0.27	0.76	0.30	0.26	0.26	0.01	0	0	0	0.98
	RFO3-(B)1	0.99	0	0	0	0	0	0	0.08	0.08	0.50	0.15	0	0	0.23
	RFO3-1	0.99	0.68	0.14	0.93	0.28	0.67	0.27	0.23	0.23	0	0	0	0	0.92
	RFO4-(B)1	1.01	0.59	0.12	0.65	0.20	0.26	0.10	0.08	0.08	0.18	0.05	0	0	0.55
	RFO4-1	1.01	0.75	0.15	0.93	0.28	0.74	0.30	0.24	0.24	0	0	0	0	0.97
	RFO5-(B)1	5.49	0	0	0	0	0	0	0.44	0.44	2.75	0.83	0	0	1.27
	RFO5-1	5.49	3.78	0.76	4.39	1.32	3.73	1.49	1.28	1.28	0.03	0.06	0	0	4.91
	RFO6-(B)1	2.06	0.88	0.18	1.09	0.33	0.37	0.15	0.08	0.08	0.20	0.06	0	0	0.80
	RFO6-1	2.06	1.43	0.29	1.66	0.50	1.40	0.56	0.47	0.47	0	0	0	0	1.82
	RB1-(B)2	4.33	0	0	0	0	0	0	0.35	0.35	2.17	0.65	0	0	1.00
	RB1-2	4.33	2.98	0.60	3.46	1.04	2.94	1.18	0.64	0.64	0.02	0.01	0	0	3.47
7	RB2-(B)2	3.42	0	0	0	0	0	0	0.28	0.28	1.71	0.51	0	0	0.79
	RB2-2	3.42	2.35	0.47	2.73	0.82	2.32	0.93	0.51	0.51	0.02	0.01	0	0	2.74
17	EW1-6-(B)1	1.17	0.12	0.02	0.13	0.04	0.05	0.02	0.09	0.09	0.40	0.12	0	0	0.29
	EW1-6-1	1.17	0	0	0	0	0	0	0.28	0.28	0	0	0.99	0.40	0.68
	EW1-6-(B)2	0.96	0.10	0.02	0.10	0.03	0.04	0.02	0.07	0.07	0.33	0.10	0	0	0.24
	EW1-6-2	0.96	0	0	0	0	0	0	0.23	0.23	0	0	0	0	0.55
23	SAQ1-(B)1	0.51	0	0	0	0	0	0	0.23	0.23	0	0	0.81	0.32	0.23
	SAQ1-1	0.51	0.45	0.09	0.48	0.14	0	0	0.39	0.39	0	0	0	0	0.62
14	HFC1-(B)1	6.92	0.83	0.17	1.11	0.33	0.28	0.11	0.55	0.55	2.63	0.79	0	0	1.95
	HFC1-1	6.92	0.01	0	0.01	0	0	0	5.03	50.3	0.03	0.01	0	0	5.04
21	RLOW1-(B)2	3.33	0.67	0.13	1.00	0.30	0.20	0.08	0.30	0.30	0	0	0	0	0.81
	RLOW1-2	3.33	2.72	0.54	2.91	0.87	1.02	0.41	0	0	0	0	0	0	1.82

Arden Bar Worksheet (cont.)

MEAS.	COVER-TYPE/ ALTERN.	AREA	CA VOLE		OWL FV		OWL CRV		SFCM		OWM		EMM		TOTAL AAAHUs
			AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	AAHUs	AAAHUs	
7, 9	OWS1-(B)1	21.27	15.31	3.06	19.14	5.74	6.38	2.55	0.43	0.43	0.43	0.13	0	0	11.91
	OWS1-1	21.27	18.25	3.65	20.51	6.15	10.37	4.15	1.22	1.22	0	0	0	0	15.17
9, 24	OWS2-(B)1	6.41	0	0	0	0	0	0	0	0	0	0	0	0	0
	OWS2-1	6.41	5.23	1.05	5.59	1.68	1.96	0.78	0	0	0	0	0	0	3.51
	OWS1-(B)2	6.41	0	0	0	0	0	0	0	0	0	0	0	0	0
	OWS1-2	6.41	5.23	1.05	5.59	1.68	1.96	0.78	0	0	0	0	0	0	3.51
9	OWS2-(B)2	13.13	9.98	2.00	12.34	3.70	4.20	1.68	0	0	0	0	0	0	7.38
	OWS2-2	13.13	12.08	2.42	13.08	3.92	7.27	2.91	0	0	0	0	0	0	9.25
	OWS3-(B)1	1.13	1.13	0.23	1.13	0.34	0.34	0.14	0.09	0.09	0	0	0	0	0.80
	OWS3-1	1.13	1.04	0.21	1.00	0.30	0.55	0.22	0.16	0.16	0	0	0	0	0.89
	OWS3-(B)2	1.13	1.13	0.23	1.13	0.34	0.34	0.14	0.09	0.09	0	0	0	0	0.80
	OWS3-2	1.13	1.04	0.21	1.00	0.30	0.55	0.22	0.16	0.16	0	0	0	0	0.89